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Dr. R. H. Fernald, chosen by the Society at the annual meeting to be its President for the ensuing year, resigned from that office July 19, and under the terms of the Constitution was succeeded by Mr. A. J. Himes, Vice President. On July 19 Mr. W. O. Henderer was elected by the Executive Board to succeed to the office of Vice President, Aug. 1. The above list of officers is now correct.

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Report of Annual Meeting

FRANK C. OSBORN, THE TOASTMASTER:—

The first part of this evening's contract seems to be pretty well disposed of:—

The aggregates, from soup to nuts, have been tested and tasted, and the concrete mixed and placed within our forms. The concrete should now be permitted to set quietly, by having the forms sit quietly, while the various parts of the superstructure are developed.

As citizens of Cleveland we are all interested in and proud of our public schools and as engineers we should be particularly interested in our technical high schools.

In East Technical High, we have a splendid building. This is quite natural, of course, because the architect, Mr. Barnum, is a member of this organization. The school is splendidly equipped and during the past year has cared for over 1,200 pupils. The grand good work that is being done in this institution is due, more than to any other cause, to the masterly ability and enthusiasm of another member of this Society, Professor J. F. Barker, who will speak to us about "The Incubator Stage in the Development of Engineers".

PROFESSOR BARKER:—

I have been asked to speak on the subject "Engineers in the Incubator Stage", presumably from my contact with the youth of our city preparing to take up the study of engineering. After so many good things, it is difficult to offer much that will be palatable. I do not hope to give you very much additional food, except for reflection, but I do hope to offer one thought which you may take from this meeting with you, and perhaps it will bear fruit, because it seems to me it is a civic problem in which we are all interested.

In my position in the school I come in contact with people who have very strange ideas as to what an engineer is, and as to what constitutes engineering. I presume this is in part due to the advertising schemes of certain schools, which picture the man behind the desk and the man waiting for a job. These advertisements lead people to believe that the little smattering of drafting to be gained in a few hours constitutes engineering. So we have people who come to us for night school work and say that they want to study engineering. We ask them, "How far did you go in school?" "Well, we quit at the sixth grade, but we would like to study engineering." Of course, they are told that such an institution as we have can't hope to teach engineering; if we can teach them to read a drawing, we are doing well. It is ex-

plained that to study engineering one must have at least a high school education. Such applicants turn away disgusted with us, thinking we do not know whereof we speak. Today a mother came to me and said she wanted her boy to study electrical engineering. She said he was a natural born electrician. He was a little boy in short trousers, who had installed an electric bell somewhere. I told her we could not begin to instruct him in electrical engineering and she was very much disappointed. And when she found that at some remote date, with proper preparation, he might study engineering, she was greatly chagrined. By explaining to her that he could study electrical construction so that he could work at the trade, she went away quite satisfied and resolved to send the boy to school.

Of course, we have a great many boys in the incubator stage, who are potential engineers, and our greatest difficulty is to select and find out which of them could really become engineers. I came from a seafaring family of Nantucket, and when I was a little boy, my great ambition was to be a sailor. I well remember going out on a fishing smack, and as the little boat floundered around in the trough of the sea, my ambition to become a sailor went down just in proportion as other things came up. At 16 I wanted to be a photographer and later I had some friends who convinced me that I wanted to become a mechanical engineer. I went to Cornell and studied, and after I was about half through, I thought I would do better as an architect, so I took an architectural degree and finally here I am, a school teacher.

Now, such are the vicissitudes that most of us go through in connection with the choice of a vocation. And yet how are we to determine in this incubator business which are the good eggs and which are the ones we do not wish to incubate? How are we to pick the potential engineer and develop him? Cleveland is not very fortunate in having anyone who has helped us, so far, in the solution of this question. In Pittsburg, a wealthy woman donated \$250,000, the interest of which is to be devoted to finding out what boys can do, and what girls can do, and then guiding them in their chosen vocations. The city of Boston has a committee which is concerned with the guidance of youth, and in the grammar schools now, they have vocational guides, whose business it is to direct the energies of the girls and boys so that if they are potentially artists or engineers or business men, and so on, they may be directed in the right channels. A vocational guidance bureau is not an employment agency, not a scheme whereby employers may secure employes, or by which girls and boys can get jobs. It is rather an adjunct of vocational education. A plan whereby the right kind of employment may be found for the right kind of a boy. And one of the great problems in this city is what to do with our boys and girls and how to help them to select their life work.

We have 6,000 children every year leaving school with but a sixth grade education, and they go out into the world and become errand boys, or elevator boys, or telegraph boys; they do not select a vocation, they simply want to get away from us at the school. They enter blind alley vocations. They do not go out

into the world with any definite idea as to what they can do or how they can do it. And we do not provide them with any knowledge of what the different trades and vocations offer, what future there is in the machinist's trade, or the patternmaker's trade, or what the girl can do in the suit and cloak business. What we need in this city is a bureau which will investigate our industries and find what opportunities there are, what wages are paid, what the future is and what return a boy is going to get if he goes into this, that or the other line of work, whether a manual trade or a profession, and further what are the requirements of the vocation.

And so we should have something of this sort in Cleveland, we should have a bureau of vocational guidance. Of course, we attempt this in the schools in a small way, but most of our school teachers know little about the industries of our city and they are unable to offer vocational advice to the boys and girls. When the pupils come to us in high school, they are pretty well weeded out. In our first grade we have 14,000 children, when they are in the last year in high school there are only 700 left, so the process of weeding out is taken care of very well. Of the 700 who graduate less than half are boys and from this number only a small percentage enter engineering college courses. By this time most of the undesirables or unfit are gone, but in spite of this we have some misfit engineers.

Now what to do with this army of boys and girls, 6,000 per annum, is one of the great problems of such a municipality as ours. I trust and hope that some day we will have a bureau for vocational guidance established in the city of Cleveland, which will offer advice, that will know and keep posted on the opportunities in our industries, so that when we have a potential engineer we can tell him what field is open to him, so we can select him with due respect to the place he is to fill and not try to put square pegs into round holes or attempt to incubate sterile eggs.

THE TOASTMASTER:—

The Program Committee seems to have omitted the "broiler" stage from the specifications. Possibly they could not find any member of the Society that they thought able to do the subject justice. I will, therefore, tell you about a gentleman, who was commenting recently on the changed conditions of living since his boyhood days and said that in former times, when the family wanted chicken for dinner, somebody went to the chicken yard, killed the chicken and turned it over to the cook. In these times the chickens come from some refrigerator, where they have been in cold storage for 16 years or so—well, some people like 16 year old chickens.

There is another institution of learning in this city that ranks with the best of its kind. It is comparatively young, but, as Mark Twain said, "Time will remedy that." It has graduated many men, who have attained eminence in their chosen field. Its faculty contains a number of men of well earned national reputation and

among them is one whose work as a chemist and particularly in by-products of oil entitles him to rank in his special field as another famous oil man does in his.

I have the honor to present Dr. C. F. Mabery, who will tell us about "The Brooder Stage, in the Development of Engineers".

DR. MABERY:—

Mr. Toastmaster, and gentlemen: I feel a serious responsibility this evening, for two reasons, one because I am asked to represent the institution, the Case School, of which you all know, and, in the second place, because, as the Toastmaster just mentioned, I am a chemist, and while I think I know a little something about engineering, I am not really an engineer.

I am much impressed by the remarks of Mr. Barker, concerning the situation in the Incubator Stage, for in the Brooder Stage, there are certain closely allied conditions. I am not altogether sure, but that he and I, if managing the situation, would have to go a little farther back than what appears as surface indications. It has been said that a man is made in his protoplasm, that if he has energy and inherent ability, he will meet with success, whatever may be his walk in life. Perhaps some of you read, some years ago, the interesting work published by the late Professor Dolbear, of Tufts College, relating to "Physics and Life", in which the author expressed an opinion that we might be ready at any time to expect a solution of the problem of life—that inanimate matter might be put together in such combinations and under such conditions, as to produce life. I think I have read an account of some experimental work done by some biologist in that direction, wherein he has taken what seemed to be perfectly inanimate matter, and out of it has created the life germ. If that be so, there is some hope that the matter may be taken up in an experimental way, on a reasonable basis, for the development of material that can be relied on in the Incubator and Brooder Stages to make an engineer of the first grade. Of course, the biologist who undertakes such a task in meeting the modern demand for quick results must leave out some of the intermediate stages through millions of years of the gradual evolution through the snake and baboon stages to man. If he is able to create life, then, of course, he must, in the first place, size up the qualities that the successful engineer should possess, and in that he will call to his aid whatever assistance he can obtain from other departments of science in ascertaining the necessary mental and physical qualifications. The phrenologist, the physiologist, the psychologist and the chemist will all be ready for their part. We are told by the physiologist that he can measure thought and the range of its effectual operation. If that be true, and he can be relied on for the diagnosis of an individual as to his mental balance, it may be possible to construct a normal engineer by ascertaining what particular traits will insure him the best success in his profession.

Having obtained the specifications, the next step will be to

construct the engineer. Evidently the beginning must be made with the ultimate protoplasmic germ. The chemist knows now the composition of pretty nearly everything that enters into the composition of man. I remember once seeing, in the Bethnal Green Museum, just out of London, a series of bottles containing specimens of the solid substances that compose the physical structure of an average man. I think a similar collection may now be seen in the Smithsonian Institution at Washington. But the chemist has recently made further progress and he now knows that the protoplasm is composed of such elements as carbon, hydrogen, nitrogen, phosphorus, etc., and has a general idea how those elements are put together. Now, if he can get together with the biologist with the specifications of the other co-workers, they may be able possibly to work up to a point where we may hope, in the brooder stage, to have the sort of individual we need for the production of a successful engineer.

I was impressed, a few years ago, by reading, in a book edited by Dr. Thwing a statement that the educational institution is often expected to accomplish for a student in four years, what the home has failed to do in the first eighteen years of his life. I think that is a very general idea of what is expected of the educational institution. But it is erroneous. If the individual comes to the college with the right qualities—energy and inherent ability—he can be given a foundation for success in life. Otherwise no amount of training can make him successful as an engineer or in any other profession.

It is a serious thought that when a young man enters an educational institution, he becomes an essential constituent of the institution as long as he lives. Of course, it is the foundation of his fortunes if the institution does its duty. At the present time, he cannot, certainly, escape the connection; I presume we all have frequent reminders from a financial point of view in the demands on our pocketbooks. But the individual has his future molded by whatever is done for him in his institution, and it is a serious responsibility for the institution. It is incumbent upon it to be thoroughly in touch with the progress of things throughout the world, to keep somewhat in advance on lines of research, as to what should follow from present conditions, and to give the embryo engineer the advantage of what is best suited to a professional education. After all that the institution can do, the engineer goes out into the great school of life, where he gets his business training. In the great field of activity he succeeds or fails, according to his ability to make use of his attainments and opportunities.

We frequently hear the question asked, as to the best thing that comes to an individual, who graduates from an institution. Many replies are to the effect that one of the best things in an institution of learning is the incidental association with faculty and fellow students. The young man entering an institution with unformed ideas and crude conceits, coming in contact with others having equally decided ideas and conceits, soon finds his place in his community in a way that makes him a better man. Often we hear it stated by eminent and successful men that the best part of

their college life was the association with some particular man in the institution: some member of the teaching force had such a strong personality, such a hold on the details of his teaching, and also such influence with students that an impressive memory of his instruction and personal influence remained with the graduate in his later work. Perhaps the personal influence was more especially evident in the older institutions than in those of the present day. But there is no question that the element of personality in teaching has a far reaching influence. The graduate will forget his mathematics, his physics, and the details of his course—the general training, of course, remains—but his associations and the influences, under which he has come, will often be the essential element in his future success. That certainly is a great responsibility for the institution. The institution does its duty along educational lines in making a successful engineer, but the incidental influences and associations often have an equal and perhaps a greater effect upon the individual in developing a proper frame of mind to deal with the great problems that come in his way when he gets out into the business life. (Applause.)

THE TOASTMASTER:—

As an engineer gains in experience and ability, he is given more responsibilities, advancement follows advancement, and when he shows unusual ability he sometimes becomes general superintendent of an important railway line. Promotion, however, should not affect an engineer as it did the Irishman who was put in charge of his section gang. One of his men began to talk back to him one day, so he said, "Shut up, Mike, I want nothing but silence out of you, and damn little of that."

In listening to the next speaker, please do not be disappointed if you do not hear "silver-tongued" oratory. It may be only "Nickel Plate".

I take great pleasure in presenting Mr. Albert W. Johnston, who will speak of "The Private Employer of Engineers".

MR. JOHNSTON:—

Our genial Toastmaster said that he was going to get in one on me when he introduced me. Osborn knows there is a chestnut blight spreading all over the country and he saved just a few of them for me this evening.

I am going to refer to another chestnut. When a man was asked what he was going to talk about, he said about ten minutes. My friend, Roberts, told me I was going to talk "about five minutes". Now, I find that I am put down for the topic, "The Private Employer of Engineers".

I have had some little experience as a private employer of engineers, and one of my first experiences of that sort was some years ago, when I was a youngster in charge of a party on the old Pan Handle R. R. line. I had a vacancy on the party, and a young man down at Columbus wrote me that he would like to

have the job on my "corpse". (Laughter.) Of course, I was fully resuscitated, or I wouldn't be here now.

I notice the first speaker spoke of the "Incubator Stage", and my friend, Dr. Mabery, has spoken of the "Brooder Stage". Well, I suppose before you can try an egg in any sort of practice, it has got to be hatched out. We all remember our very dear friend, Aleck Brown. Well, some years ago it was my pleasure to be one of several to escort the president of the institution which is my alma mater, on a visit to Cleveland, and that institution had some of its graduates in the employ of Aleck Brown at that time. The principal was very anxious to meet Aleck. I trotted him around to the Brown Hoist, and Prexy said to Aleck, "I understand you have several of our boys here, how are they?" And Aleck said, "Oh, about average." That didn't set well on Prexy, and he came back and asked us what the matter was, and he found out.

That leads me to another thought. Some years ago I had charge of the construction of a railroad in Kansas. We had built a hundred miles of line and had authorized an extension out into the prairie country. The engineer who made the preliminary location was an old-timer in that section of the country. He originally came from New England. I sent for him and said, "Mr. Barnes"—by the way, he was one of the early settlers out there, and he stayed over in Iowa for a long time because, when he first went to go across to Kansas, the pro-slavery Democrats made him say "Cow", and as he said "Caow", they wouldn't let him in. I told him what we wanted him to do. He said, "Mr. Johnston, what kind of a railroad do you want me to locate?" I said, "You have been building roads in this part of the country all your life; you know the kind of road we expect to build." He thought a minute or two and said, "Well, Mr. Johnston, I rather expect I know the kind of railroad you want me to locate. You want me to locate an average Western railroad, capable of improvement." (Laughter.) Now, the kind of a graduate that Aleck Brown had was capable of improvement. Of course, the young graduate who comes out of school knows everything; when he gets to be as old as my friend, Osborn, and myself, he doesn't know very much. But in the meantime he is an average man, "capable of improvement", and that is the fellow that I have had to deal with in the last thirty years in railroad engineering work.

Of course, the profession in its entirety has some misfits. The professions who preach and those who practice and those who are always consulting the authorities have some very bad cases of misfits. But the average misfit in our force has to work in the open, and his failures soon become known and he disappears. So, after a time, the average man, who has been capable of improvement, improves; I have found him so.

It has been said that genius is the capacity for hard work. I don't suppose the average engineer is a genius, as we understand that term ordinarily, but in his capacity for hard work and what he accomplishes he is a genius. We may be asked what does the average engineer accomplish in private practice? You have only

to work around him. He contributes to the material improvement of life on every hand. I have found him conscientious, diligent and to be depended upon. We all know that the profession of railroad engineering is a hard school, and the average man who does not improve does not last a very great while, and the fact that the ranks today in the engineering profession, in railroading, are full of more than average men, has shown that the average graduate has improved and made good. (Applause.)

THE TOASTMASTER:—

Generally speaking, engineers ride in automobiles, but sometimes every machine we have is in the shop, repair shop or pawn shop, and it is necessary for us to use the street cars.

We find at certain hours that the cars are quite fully occupied and that the strap-hangers' union is a large organization. At these times also, when some one besides yourself is standing on your feet, you feel like delivering an address to the secretary of the Cleveland Railway Co. However, holding the strap yourself is better than in our boyhood's days, when father held the strap with the buckle at the other end.

This brings up tender recollections and perhaps I had better tell an expert witness story.

Some time ago, Mr. Davies and a friend (I am not sure whether it was Peter Witt or A. B. DuPont) were touring Italy and visited the famous Leaning Tower of Pisa. A discussion arose as to whether it leans by design or accident. They could not agree and an engineer was called in, who said he had *good foundation* for the belief that the owner was insolvent, could not pay his bills, so the mechanics put a *lien* on the building. Never having been removed, it is there still, so it is a *lack* of settlement that caused the *apparent* settlement.

I am sure we will now enjoy hearing from Mr. Henry J. Davies, secretary of the Cleveland Railway Co., who will tell us what he thinks about "Engineers for Expert Testimony".

MR. DAVIES:—

Gentlemen, after your President asked me to speak on this topic, I went to the dictionaries to find out exactly what an engineer is, and I found that the leading American dictionary, as well as the leading English dictionary, defined him as "one who carries through *a scheme* or enterprise *by skill or artful contrivance*." (Laughter.) Other definitions indicate that he also conceives or evolves the scheme, and invents and constructs the contrivance. Think of the sixty-brain power implied in those definitions! They almost kept me away from this meeting, from awe of you. They make the phrase "efficiency engineer" seem tautological.

Since I began the study of engineering—two or three days ago—I have come to have a higher respect for your profession than I had before—and I have always had a very high respect

for it. It seems to me the most desirable of businesses, involving, as it does, that most delightful occupation—the exercise of the imagination; for *you* may dream without being suspected of neglecting your work. Every great engineering feat is imagined before it is executed. Every step in material progress has been preceded by an engineer's dream. But not that alone. The engineer is a combination of the visionary and the practical man. You build as well as plan. Not all your dreams have come true—not yet. But your profession—at least, the latest branch of it, efficiency engineering—is young, and I can imagine, and my imagination is not trained like an engineer's—even I can imagine that the time may come when you will make of every vision a verity, and of every desire an excuse for another day-dream, which, by artful contrivance, you will cause to come true.

But to my subject, “Engineers for Expert Testimony”. The man who penned that phrase was a “tautologist”, for every engineer is an expert, and every engineer's statements are expert testimony. In court or in arbitrations, engineers, I presume, are a great deal like other experts. I have heard many experts testify, and have noticed that there were usually about as many on one side of a case as on the other—all honest, so far as I knew. If I had been the jury in any of those cases, I think I should have had to disagree with myself after hearing the testimony of the experts on both sides.

One eminent engineer whose acquaintance I enjoy told a story of an early experience of his in valuing a railroad property. I do not remember whether it was a tax case, in which he sought to show a low value, or a rate case, in which he tried to prove a high value. He had been examined by the attorney for the railroad company, and at the luncheon hour talked with the president of the company about the questions that would probably be asked him by the attorney for the other side in cross-examination. He imagined many questions, and asked the president how to answer them. He supposed a hypothetical case that worried him a great deal, and asked, “Mr. President, how would you answer that question?” And the president, after a long pause, said, “Well, I guess in that case you'd better tell the truth.” (Laughter.)

My principal experience with expert engineers as counsel and witnesses was in connection with the appraisal of the street railway properties here in 1907, 1908 and 1909. We examined our own engineers and others as to the extent of the physical property and the cost of construction. We also called expert engineers of the widest reputation to testify not only as to the value of the property that appeared on the ground, but as to how much should be added to that value for what they termed “overhead charges”, including contingencies, things that could not be seen on the surface, such as organization, engineering, legal expenses, interest during construction, consents of lot owners, brokerage, financing—perhaps twenty other items. With their wonderful imaginations, they saw many things that we had not seen. And they proved their dreams. By most convincing arguments, they showed that the things they saw in imagination were real. Among the engineers that we called were William Barclay Parsons, Bion

J. Arnold and Professor Mortimer E. Cooley, of the University of Michigan. I remember a story that Thomas Bailey Aldrich once told of his boyhood. Among his playmates was one who was always their leader, or who was always successful in their games, who won their marbles, whose kite flew highest, whose sled coasted fastest. They agreed one summer day that the next morning they would fly their kites, and would name them all. One of the boys named his "Morning Star". Aldrich named his "Excelsior". But the boy who was the winner, always, had spread all over his kite, "Nearer, My God, to Thee". (Laughter.) Arnold was our bright Morning Star; Barclay Parsons was Excelsior; but Professor Cooley came nearer, my God, to Thee, in the matter of *overhead* charges, than any of the others. (Laughter and applause.) If I am wrong about that, Mr. Baker will correct me.

But, as I say, Professor Cooley and the others backed up their statements with very cogent arguments. Professor Cooley had such confidence in his own testimony and in his profession that he said that he believed his estimates were under-estimates, the art of valuing second-hand railroad properties being still in its infancy. The engineers added varying percentages, saying that their experience indicated that in most works as large as a city street railroad the actual cost usually largely exceeded the engineers' estimates, in some cases by as much as 50 per cent.

But what was the use? In spite of their expert testimony, Judge Tayler allowed us but about three million dollars for overhead charges, on top of what had been allowed by Mr. Goff and Mayor Johnson, earlier arbitrators, and we were broken-hearted. Both sides, Mr. Baker says, were broken-hearted. (Laughter and applause.)

There was one overhead charge, or expense, or waste, that used to trouble us somewhat before Roberts became a Democrat and abolished smoke; but my time is up, and I shall have to leave that to your imaginations. (Laughter and applause.)

THE TOASTMASTER:—

We are particularly honored this evening in having with us the president of the Cleveland Chamber of Commerce. This organization is the best of its kind in this country. Mr. Johnson himself admits it. Its great success is due to the fact that its membership is made up so largely of men of the type of Mr. Johnson, men, who are leaders in the business and professional world and whose time is extremely valuable, yet give it freely and unselfishly to further the work of the Chamber in its efforts to promote the best interests of Cleveland and its vicinity.

The fact that Mr. Johnson has been honored with the presidency of the Chamber of Commerce is proof and recognition of his own good work already done for the Chamber and an expression of confidence in his ability to direct a continuance of splendid work by the organization.

Gentlemen, I have the honor to present to you Mr. Homer

H. Johnson, president of the Cleveland Chamber of Commerce, who will speak of "The Value of an Engineer as a Member of Societies for Improving Civic Conditions".

MR. JOHNSON:—

Mr. Toastmaster and Gentlemen of the Cleveland Engineering Society: Henry Davies' remarks reminded me of the legend in my profession which runs that there are, of a certain class of our people three distinctive types, the liar, the damned liar, and the expert witness. Henry has endeavored to shift the responsibility for the expertness of that witness over to the president of the railroad, but I think you gentlemen will have difficulty in escaping all the responsibility for the implied epithet which he handed you, but you did not notice it. Henry asked Jimmy Hoyt once to respond to the toast, "The Street Car Question from the Standpoint of the Car Rider", and Jimmy said it was thus admitted that the passenger had only a "standpoint".

That reminds me of the young lady going home a few days ago with one of those new skirts on, that some of these old bald-heads have noticed—you cannot tell whether they are overalls or a riding skirt. This young lady got on a street car; it was very crowded—I don't know that I need to have stated that. There was a fine looking gentleman standing close behind her, and she could hardly stand, the crowd was so thick. She saw the conductor coming—this was just before the fare box was a success. She reached around to get a ticket, and showed some embarrassment, and finally reached around again and hunted the ticket. This was repeated a third time, and the gentleman said, "Madam, won't you permit me to pay your fare?" "No, indeed," she said, "you insult me. I prefer to pay my own fare." "Well," replied the gentleman, "as you have put your hand in my trousers pocket three times in succession, I thought I might be of assistance to you." (Laughter.)

I am between Mr. Baker and Mr. Davies on this program, and so I am supposed to be the peacemaker between the city and this oligarchy of officeholders that is running our street cars. They will need another arbitrator soon, and as Fred Goff is now out of the business, we might send our cards around.

This question of "The Value of an Engineer as a Member of Societies for Improving Civic Conditions" brings up another question, as to how far a body like the Chamber of Commerce, composed of yourselves and other business men of the city, to the number of 2,200—I hope it will be three thousand before long—what the function of that body should be with reference to the purely business side of the civic questions that arise in every community. The Chamber is limited, of course, by the means it has at its disposal. We can't pay in much more than twenty-five or thirty dollars a year to the support of that institution, and couple with it our other activities. So as between the strictly business questions, such as the location of new factories and industries in our midst, the question of taking care of freight

tariffs, and the question of the routing of freight, the question of the facilities for the carrying of freight, facilities for loading and unloading, warehousing, the question of facilities to do business, of making this a good manufacturing town—all those questions are business questions and mighty important in a community in which we have our homes. In other words, if no one in particular attends to that, what is everybody's business is nobody's business. And there must be somebody who takes the community as a unit, calls in the engineers by resolution, from the Cleveland Engineering Society, if you please, and gets all the advice we can to determine for us—in a large way, for the entire community, what is for the benefit of its business element. Now, that is a highly important and desirable function for any society to fill, and I know you are proud of the record that you, as members of the Chamber of Commerce and of your own Society, have had in that direction.

On the other hand, in our form of political government, when the government may be changed every two years (addressing Mr. Baker), not likely to, but it may; that being a possibility always, there is a certain unstable element in the people who are set over us to rule us; and a society such as the Chamber or your Society, being continuous, having no axe to grind except the common good, may take a longer and a wider and a clearer view of some of those questions for the improving and bettering of public service, than the public servants are by any possibility able to give it.

That standpoint represents the civic side. In other words, we want to make this city the best possible place in which to live and to make a living. We desire to give it all the facilities from a business standpoint, and we desire to have its affairs economically administered, its streets kept clean and well paved, to have it an orderly and comfortable city, where anybody will wish to live who wants a job or who has money and wants to spend it. We are criticized on the one hand by many business men, because we devote too much time to civics, and on the other hand, by another class, for spending too little time on civics. We want your help to decide those questions correctly, but we want you, above all, to pay attention to the subjects involved, so that your criticisms will be intelligent and your suggestions helpful. We might today have an additional committee in the Chamber of Efficiency Engineers. Suppose, for instance, we had a Public Works Committee—not to say that all the public servants are grafters, we are away past that. The day is one of mutual self-help. We are mutually helpful, and I have great pleasure in saying to you that the co-operation of the present administration, with the chamber, both of the city and of the county, is ideal. That is the ideal condition, and if we do our part as members of the Chamber of Commerce and as members of this body, I know we will have no difficulty in dealing with the authorities in the county court house and in the City Hall.

If we could have an Efficiency Committee on Public Works that would take care of public contracts with a watchful eye, not intruding itself into the official position, but seeing that the public

officials, through whatever motive, may have overlooked some points that you and I, as good citizens, wish to bring to their attention—that, I think, is the highest function of the Chamber of Commerce, though I think that the business effort ought not to be lost sight of.

That brings me to the last point upon which I was going to address you, and that is with reference to the men who are in what might be called the adjective vocations, those vocations not directly connected with production. We are in the employ of others who are supposed to be making the money. We are supposed to look on and see them do it and help them spend it. But those people engaged in that business, what is their duty toward the general subject? I take it, as Shylock says, that “thrift is a blessing if men steal it not.” Every man’s duty is to make a living, and make it honestly, yet if he may, by his money and his enthusiasm and his good example, help along the common good by connection with bodies like this and the Chamber of Commerce, it is his duty so to do. In other words, we are all in the boat together, and unless we do our part, there is no one to do it; and to concentrate the combined efforts of 3,000 men in a city like this, intelligently led, considering these questions, its importance cannot be overestimated. I bespeak from you gentlemen all the time you can find from your business to help make this city, in which we live, an even better city than it now is. (Applause.)

THE TOASTMASTER:—

It is certainly interesting to hear a lawyer get up before a body of engineers and speak of somebody else making the money. (Laughter.)

We are also honored tonight by the presence of the Mayor of this sixth city of the United States. We are not here tonight as politicians or partisans, but as engineers and citizens of the great city, of which Mr. Baker is chief executive.

No mayor of Cleveland has ever shown himself a better friend of engineers than the present mayor. No mayor of Cleveland has ever shown himself more appreciative of the services of an engineer than the present mayor. When engineering questions of the greatest importance have been before him, he has endeavored to get the best engineer obtainable for the problem in hand, and he has been liberal in the remuneration provided for these expert engineers. We admire the mayor for his position in these matters and feel that he is our friend. We are glad to have him talk to us on the subject of “Municipal Employment of Engineers”.

MAYOR BAKER:—

Mr. Chairman, I suppose it is by reason of some contagion in the air that my good friend, Mr. Johnson, thinks he is going to break the precedent long established in the Chamber of Commerce and be president more than one term, for it is manifest

that he expects to be president of the Chamber of Commerce longer than I am to be mayor, or else there could be no superior continuity or more continuous policy in the Chamber of Commerce as contrasted with the city government. I am a member of the Chamber, and I will vote to abolish the precedent in his favor. (Laughter.)

I have been very much entertained, too, and highly delighted in hearing what my good friend, Mr. Davies, had to say. In the first place, it is pleasant to know that the rigors of the war that was waged so long around here have sufficiently abated to enable him and me to engage in pleasantries about what at one time seemed to be a serious controversy. But the particular delight I have about it is to hear that the magnificent, gauzy and somewhat insecure structure built up in Judge Tayler's court room on the subject of values, was not really the creation of the imagination of Mr. Davies, but was forced upon him by wicked engineers from the outside (laughter), and that it really never entered into the head of Mr. Davies or Mr. Andrews that their property was worth anything like what they said it was, but that they had to send off and get the Panama Canal engineer, wasn't it, one of them, and the nurse of the science of valuing second-hand street railroad properties, to come down and tell them about the great wealth that they actually had, but never had supposed belonged to them at all.

As a matter of fact, the controversy that was waged in Cleveland on the valuation of the street railroad property illustrated what I am glad to think is a past phase of the relation of the engineering profession to municipal activities. So far as Cleveland is concerned, I am entirely satisfied, both by my own experience and by my observation, that that phase is past. We have lived through, in the United States, a very singular situation so far as the relation of municipalities to engineering is concerned. Very many of the most important functions of the public life of our cities have been performed by private individuals and private companies. But that was rather a growth than the result of any settled policy. When street railroads, if I may illustrate by the first thought that comes to my mind, when street railroads were first projected in the United States, they were manifestly highly hazardous enterprises for capital to invest in. They were undoubtedly tentative; their experimentation was costly; it was the sort of thing that no municipality could properly have then been expected to go into, and private capital went into it as a speculative enterprise. That is equally true of gas and of the various developments of electricity in a public way. So that there came to be in our cities a private ownership and control of or at least a dominant private interest in the furnishing of public utilities of various kinds, which made perhaps the largest draft upon the engineering talent of the country. The result of that was that the engineers of the country, who were engaged in those kinds of engineering, were all enlisted on the side of the private interest that was involved in them. I regard that as an entirely natural situation, and yet doesn't it seem singular to you gentlemen, who are members of the profession of engineers that in all the United

States there are perhaps only a handful, I hesitate at numbers, but there are only a handful of men of long experience and large renown in the various engineering professions, who could be gotten to testify on the public side as to the valuation of a public utility. Every public service and utility commission in the United States, and some of the states have had them, permanent commissions, and every city that has been called upon to enter into the question of rates or valuation of public utility property for the purpose of rate making, has been confronted with the situation that all the engineering talent specially devoted, and specially equipped and specially experienced in those lines, was already pre-empted on the private side, and that the public has but a very few engineers at its disposal in those various lines.

Now, I think that the line of division has largely passed away. The time is coming when the expert witness, not only in the engineering profession, but in all other professions, as we knew him in the yarn that Mr. Johnson told about him, is going to disappear, and be forgotten. Surely, the expert witness on a medical question, who is hired on one side or the other and is expected to give only such testimony as will support a certain theory of the case, is a man that has almost ceased to exist. Doctors of the first order and first rank are now men of exact science, men whose first loyalty is to their science. And so of engineers. I think we are going to have a very much greater readiness in getting the best engineers on whichever side of a case the justice and equity of it may lie. Because in the United States we are coming into an era where men are learning to set a right value on their loyalty to the moral side of their own pursuits, and to set a less value on the economic side. I take a great deal of cheer from that thought, and I myself have had one or two most delightful illustrations of the fact that we are in a new age. There was a scientific problem proposed in Cleveland just a short time ago, involving the question of the filtration of our water supply, a question about which there were some rather hastily formed opinions, perhaps on both sides, but it was distinctly a scientific question, a question that affected the life and health of the entire community, and involved the pledging of the city's credit to a very large extent, if it should be necessary to enter upon the immediate filtration of the large water supply of this great city. It was in every way the sort of question that ought to have invited from the engineering profession their patriotic, public-spirited interest in its solution. And I want to take this first public opportunity to express my own very grateful appreciation for the fact that the minute that problem was proposed, the Cleveland Engineering Society, co-operating with other engineering societies that had a proper interest in that subject, began its study and devoted much time to it, and gave to the council and the executive officers of the city a most helpful report. It was an unremunerated and voluntary service, and to my mind it was an intensely public spirited and high-minded service, and I am glad of this opportunity to express my gratitude for it.

In the same way, when the question came up of selecting engineers for the city, it was no longer necessary to doubt and

hesitate and take young men who were fresh out of college, but I was delighted to find that engineers of the first rank and reputation, of the finest spirit, and of the highest talent in the city, when told that the city had need for their services, they volunteered and came out of the private into the public service; and I think nothing could speak higher for the *esprit de corps*, the public spirit of the Cleveland Engineering Society, than the fact that two members of that Society were willing to become public officials, with all the odium that sometimes attached to that despised occupation, on the call of the city.

Now, on the subject of the city as the employer of engineers, I have this notion about it, that in certain forms of *mechanics* members of a particular party are especially capable. But in all forms of real scientific engineering, political mechanism aside, the question as to whether or not a man belongs to one or the other of the great national parties is a mere stumbling block when you come to consider the employment of an engineer. And I think the city of Cleveland is now, and has been perhaps for some time, at a place where the great people of this city would not tolerate for a minute the selection of an engineer or any other technical and trained expert that the city had to have, on the basis of mere political affiliation.

That day has definitely passed, and it is most fortunate, for whatever we might think of the wisdom or the policy of enlarged municipal activity, this at least is true—the people of the United States and particularly the people of the cities of the United States, have come to realize that government is no longer merely an association for the purpose of collecting taxes and building roads and hiring policeman and hiring firemen, but that there is a civic consciousness and a social duty involved in the art of government, not necessarily paternalistic in its operation, but rather involving the aggregate solicitude and activity of all who live in the common government in the interest of every individual in that place. That means that our city governments are going to be progressive—I don't like the word, but that is what first comes to me—that they are going to take new functions, and perform old functions better than ever before. The city is going to enlarge its need for engineers, and engineers of the highest expertness. I expect to live to see the time in the city of Cleveland, when the engineers who are now employed by the Cleveland Railway Co., will be employed by the city of Cleveland, engineering for the same property; when men who have devoted their lives and acquired supreme facility and competency in work for private employers, will be doing the same work for the city and taking the same rank in their profession. I expect to see that all come about by the most natural process, without any more wars or any more heart-burnings, but because of the growth of intelligence and the widening of our sympathies. The old idea of government, that it was to do the primitive things it was established for and to provide places for the crippled and for the maimed and enfeebled and to be a somewhat charitable organization, is all passing. The mayor of a city or the administration of a city is really the captain and the field cabinet of a fighting army, the people who are trying to

produce for themselves conditions of finer life and larger happiness and better opportunity. A large part of that involves the taking over and performing of new functions on the part of the city and when that time comes, the vision that I have of it, the book that I seem to see written containing the history of it in the future, shows the figures of the lawyers and doctors and engineers and men of the technical and trained professions, all devoting themselves to the public service, as public servants, as well as citizens, with the same degree of loyalty and efficiency and the same magnificent genius that has characterized them in the past, helping to work out through government channels even improvements upon the marvellous improvements which are the result of their work in the past. (Applause.)

THE TOASTMASTER:—

At this point we had expected to hear from Colonel Millis. He is unable to be with us, however, and we will call upon our efficient secretary, Mr. Ballard, for a few remarks.

ANNUAL REPORT OF SECRETARY.

June 11, 1912.

In approaching the end of two years' service as Secretary of the Cleveland Engineering Society, I feel that I should like to make my report which the constitution requires to be a resume of the accomplishments and progress of the Society during that period, and to call to your attention the glorious work done by the two Executive Boards and the two Presidents during this time.

By the very nature of the case, as well as by virtue of constitutional authority, your Secretary is practically your Financial Manager, yet he could accomplish but little without the co-operation and support of your Executive Board and of your President.

I can tell you almost nothing concerning your Society prior to June 1, 1910, when I became your Secretary. Before that time you were at a disadvantage from the fact that you had no one who could give his entire time to the work, and your records show that you were not only not making progress, but that you were actually going backward.

One of the first conditions that I named as necessary to my accepting the position of Secretary, was that I be permitted to employ an assistant who could devote his entire time to our interest, and I made the statement that we could thereby increase the income more than enough to take care of the added expense. The results have completely justified this statement.

On June 1, 1910, your records show that you had a cash balance in the Commercial Account of \$45.26; that you had bills unpaid amounting to \$405.00, and that there had been collected in advance on your advertising contracts something like \$300.00, or

in other words, you were about \$700.00 behind at that time. The income from dues for the year beginning June 1, 1910, as set up on the books amounted to \$2,697.00. The increase in membership during that year was such that the amount we set up on the books from membership dues on June 1, 1911, was \$4,218.00, and the amount we are now setting up on the books as due from the membership the coming year is \$4,836.00.

We publish the JOURNAL OF THE CLEVELAND ENGINEERING SOCIETY four times per year.

The issue of June, 1910, cost us \$90.78 more for publishing it than we received for the advertising. The issue of September, 1910, cost us \$109.74 more to publish than we received for advertising. The issue for December, 1910, cost us an excess of \$88.87. The issue for March, 1911, cost us an excess of \$46.12. The issue of June, 1911, cost us only 37 cents more to publish than the advertising amounted to. On the issue for September, 1911, we made a profit of \$40.36. On the issue of December, 1911, our profit was \$23.58. On the issue for March, 1912, we made a profit of \$98.45.

The total cost of the issue of the JOURNAL for March, the last one we have published, was \$416.00, while the JOURNAL for June, 1910, only cost \$165.00. We are, therefore, publishing a journal now which contains about three times as much as formerly and are making a profit of about \$100.00 per issue, whereas on the other we were losing about \$100.00 per issue.

Your membership for 1909 was 328. On June 1, 1910, it had decreased to 310. During that year we added 197 new names which, counting out those who were dropped during the year for delinquency and also those who resigned and those who died, left us a total of 458 on June 1, 1911, or a net increase of 148.

*During the past year we have added a total of 88 new names with a net increase of 76, making our present membership 534.

We have just had our books audited by Ernst & Ernst, whose complete report will be published in the JOURNAL together with the complete account of this meeting. However, it would doubtless interest you to know in a general way just how we stand.

This report shows a surplus of receipts over expenditures for the past year of \$852.36. The Society is, therefore, out of debt and has a comfortable income considerably in excess of necessary expenses.

Among the recommendations which I have to make, in handing over the Secretaryship, are that we increase the number of issues of the JOURNAL from four to six annually, since we are now making a profit on each issue; this would be a source of revenue instead of an expense, and we have an excess of valuable papers which otherwise could not be published.

I also would recommend that on general principles the Secretaryship should be understood in a general way to mean an incumbency for two years. One year is hardly enough for any one to fully bring into effect whatever he may have in mind, and on the other hand a longer term than two years would seem un-

These are the reports of June 1, 1912.

necessary, for any one with true executive ability to put into full and complete operation all his ideals for the welfare and advancement of the Society and no opportunity should be presented for him to get into a rut.

The President should be an inspiration and help, and his duties should never be considered such as would conflict with those of the Secretary. The President with the Executive Board should determine the policy of the Society on every question. He should represent the Society in every way with the public and with the Chairman of the Program Committee should determine the entertainment and the character of the programs offered to the members.

Since the modesty of our retiring President will doubtless prevent him from referring to the matter, I would in closing tell you that he is the man to have the credit for the most excellent way in which your meetings have been conducted during the past year, and with the assistance of a most able chairman of the Program Committee has given you a full year of technical programs which, I believe you will agree, has been unequalled in the history of the Society.

THE TOASTMASTER:—

On the banks of the beautiful Hudson river are located three celebrated schools. Rensselaer, of course, stands at the very head—of navigation, at the least.

Further down the line, N. Y. C. or W. S., but still in a rather *commanding* position, is West Point, and at the very bottom, where the mouth is wide and very busy and open at all hours, lies Stevens Institute.

We have heard from Rensselaer quite often tonight, but are disappointed in not hearing from West Point. We will now hear from Stevens Institute, as represented by our retiring President, Mr. E. P. Roberts.

MR. ROBERTS:—

We have several Stevens men with us, and though Stevens may represent the mouth, and Troy is pretty well up from the mouth of the Hudson, he left out Vassar. Why did you leave out Vassar?

THE TOASTMASTER:—

I wanted to give you a chance to mention it.

MR. ROBERTS:—

Mr. Johnston didn't tell something that happened to him in his early days. You know he was surveying a line down in Pennsylvania, coming to Ohio. He was ahead of the party trying to pick out the best route, and he asked an old farmer, whom he met on the road, "Can you tell me where the State Line is?" "Yes, sir," replied the farmer, "it is right over that hill there. Are you in a hurry?" (Laughter.)

Mr. Davies referred to the variations between the estimates

of engineers as to the cost of construction of electric railways, and especially as to the item of overhead charges. It may interest you all, and especially the gentleman on my right (Mr. H. H. Johnson) to know that the reason for such differences is not because of inability to estimate the construction costs, but because the legal charges cannot be predetermined. (Laughter.)

You will not expect to hear very much from the retiring President; you have been hearing from him throughout the entire year. This is to be my swan song. To those who have ever heard me sing, or make an attempt to sing, it is hardly necessary to inform them that the head of my family states that I not only miss the key, but I don't even hit the lock. Sometime ago I was riding across the country in company with one of my clients—Ryan by name—and started to sing a little ditty or something of that kind, and I suddenly stopped and said to Mr. Ryan, "Excuse my singing." He said, "I didn't know you were singing." (Applause and laughter.)

But, what have we done? The Secretary stated that we have increased our membership; that is interesting, and one indication of success; but a far more important one, to my mind, is that while we have increased 23 per cent in membership, we have increased 43 per cent in attendance at the meetings. That is an indication of how the members appreciate the program provided by the Program Committee and its Chairman, Mr. Herron. The Society also owes its thanks to the various other committees, to Secretary Ballard, and to Assistant Secretary Black.

Relative to the increase in membership and in attendance at the meetings, and to the statement that an engineer cannot properly predetermine values, it might be noted that in my inaugural address a year ago I forecasted the amount of energy which would be required during the then coming year, as expended during the previous year, and estimated 22 per cent excess energy which would be available for acceleration; in other words, to keep the train moving at the same rate would require the same amount of energy, and to accelerate would require 22 per cent additional, and as the membership increased 23 per cent, which was a measure of the acceleration, it indicates a close predetermination. To further apply the railway analogy it might be noted that the increased attractiveness of the service resulted in 40 per cent increase of use.

It has also been called to your attention that the Transactions have increased in value; that we can now exchange our Transactions for those of the National Societies and for a large number of the current periodicals. Our Transactions are, therefore, more valuable to us individually and to the Society even from a purely financial standpoint.

So much for internal improvement; now for external. The policy during the past two years has been to take an interest in outside matters (the Mayor spoke of one) and there have been a number of interesting reports. I believe we all feel that our Engineering Society has not stood for what it should, and that we, individually and collectively, have not taken the place that we should as men in the community.

There are two possibilities to which I desire to call your attention. One is along the line of the work of the Technical Educational Committee, and very closely allied to it. You may know, and that Committee certainly does, that its work is very near to me. The Committee has prepared an admirable report with reference to technical education in this city, which will be published in the very near future.

Before we attempt to do anything, it is important that we find out what the situation is and where we can help. We have only a certain amount of energy, and that should not be wasted. Your Committee has given us an excellent view of this field, and the work will continue along the lines opened up by them, supplemented by the advice of the incoming Executive Board and the new Committee. I feel that we should be interested not only in technical work from the technical standpoint, but that we should be "big brothers" to all the men in the shops and the draughting room, and to the boys in the schools and colleges, informing them as to what is the function of engineers; and what is the career open to them, professionally and financially. We certainly can, if we will, assist those young men in choosing the proper vocation and giving them some idea of what it means; and then, by the way we carry on our own work, give them an ideal and an example.

The second point, and I will touch it very briefly, is, in which of the numerous ways can we be of greatest help to the community and to the nation? The engineer should, more than anyone else, be able to assist in the solution of the problems that are constantly recurring in the struggle between the employer and the employe—capital and labor. I presume most of us have at some time had on overalls; at any rate, we have been right with the men who have been doing the physical labor, and if as younger men we took advantage of our opportunities, we know the workmen's viewpoint. If you younger men take advantage of the opportunities you have now, you will join with the men, not merely in the shop, but in their outside activities. When I was a young man I spent considerable time with machinists and erectors outside of working hours and believe that I had and have a fair idea of their viewpoint, its imperfections, the limited horizon, the difficulties, and the trials. On the other hand, our work keeps us in touch with the financial side. We are able to inform the employer as to whether or not the laboring man is just in his demands, as to what the real reason for such demands are; we can also appreciate the financial side, and the practicability and the financial possibility of acceding to those demands. In other words, we can appreciate the position of each side and, therefore, why should we not be the best persons to act as advisers to both sides? This may require considerable courage. We are employed by those same financial men. We may hesitate to give them advice which they may not even ask for. To do so, of course, requires diplomacy. But we can be of material help, and if we take a strong enough position; if we obtain the confidence of our employer and of the men; if we act as men in each and every case; then we can help both sides.

A board of arbitration frequently consists of three men, or in some cases, five men, as the case may be, an equal number chosen by each side, and one man by agreement. The arbitrators chosen by the respective sides are chosen primarily because they hold views which agree with those of the side making the choice. The arbitrator chosen by agreement is selected because of the feeling of the other arbitrators that they can influence him by reason or argument, or because of politics or policy. Any analogy is liable to be strained, but is not such a procedure somewhat similar to appointing a board of arbitrators to act as umpires at a ball game? Would it not be about as reasonable to expect a decision based on the facts, and which would be accepted by the players and the public? Are not many of our State Commissions made up on about the same basis? A few have competent engineers available, or possibly one competent engineer on the board, but many of the members are not at all competent for the positions which they fill, and yet, nevertheless, such men have to pass on the issuance of securities, on all questions of a financial, technical and business character, and in comparatively few cases are the men chosen primarily for their fitness for the special purpose in view.

Now, it is very evident that if the engineers will "brace up" and remember that the engineering part is merely incidental, and that our life as men and citizens is of prime importance, then our efforts will count for far more. We are all busy, but can we not, to a degree at least, take a more active part in the life of the community? If we follow the advice given by some of the previous speakers, and by Mr. Beahan in his recent address to us, the result will certainly be helpful to us as engineers, as men, and as citizens. (Applause.)

THE TOASTMASTER:—

We have reached another mile stone in the history of the Society.

The administration of President Roberts has been exceedingly successful and satisfactory and as the Society does not advocate the third term idea, but believes in progressiveness, it has promoted the Vice President of the past year to serve as President for the coming year.

This change of position reminds us of a story accredited to General Phil Sheridan. An Irishman was mounted on an army mule which was kicking quite freely. The mule finally got his hoof caught in the stirrup, when, in the excitement, the Irishman remarked, "Well, begorra, if you're going to git on I'll git off."

Our President-elect has been a member of the Society for a good many years. He has served in the ranks and in office and always willingly and efficiently. He is one of our most valued members, and the Society takes pride in having his name on its membership roll.

I take pleasure in presenting your President-elect, Dr. Robert H. Fernald.

MR. FERNALD:—

Mr. Toastmaster, members of the Cleveland Engineering Society, and guests: Mr. Osborn quietly tipped me off as he put his watch down that a man cannot prove that he is a good talker by talking all the time, and that I was to "cut it short". You will notice I am down for an address. After the fluent address you have just had, I cannot attempt any address. I think if Mr. Davies would look at his dictionary again, he would find that the word "fluent" comes from the word "flue", meaning a hole for the escape of hot air. (Laughter and applause.)

As I was sitting here tonight, with Mr. Osborn with all his typewritten wit on one side, and Professor Mabery with all his wisdom on the other, I felt something like the old lady who was seated at table between a priest and a rabbi, and who said, "I feel very much like the leaf between the Old and New Testaments." "Oh," said one of them, "yes, I remember, that leaf is blank."

In regard to the Cleveland Engineering Society, I want to say that we have at present, it appears, some 550 members, a sound financial standing, delightful associations with the Cleveland Chamber of Commerce. We have gained the recognition of the city administration in many ways, so that our professional success as a Society seems to be practically assured. There are, however, some other phases, or at least one phase that I want to dwell upon a bit in order that we may broaden the work of the coming year. I refer particularly to the social side and the getting together spirit of our organization. Some one has said that coming to our meetings, while exceedingly interesting, is a good deal like going into an ice house. That is, a man goes to our meetings, he sees a few fellows that know each other, over in the corner, enjoying themselves; somebody says, "Let's go to the meeting." He sits in a corner and hears a paper and goes away before he has got acquainted. It seems to me that with an organization of the size of ours, this is the side we need to develop, to get together more closely, not only from the professional side, but for forming the social acquaintance and the pleasant association that comes from knowing each other. It is just as important for us to know the men above us as the men below us, and the men below us as the men above us. One cannot get along without the other, and we want in this organization to get a closer acquaintanceship one with another. We cannot succeed, even in our professional life, unless we are big enough, broadminded enough, sympathetic enough to get in touch with humanity, not only in our own organization, but outside, and to give and take with those around us in our organization, and with other civic bodies and with the city as a whole. It is all right to recognize that a diamond in the rough is a mighty good stone, but it is easily passed by by the person who is not experienced in picking it out. Any of us will stop very quickly at the polished gem. We need as engineers, I think, not only to recognize our inherent potential energy; we need to look out a little bit more for the polished gem; and I think in our organization, if we could get together more socially, if we would extend the hand of greeting

to everybody that comes in, that we could do a great deal toward developing the Cleveland Engineering Society during the next year.

There are just three or four things that I would emphasize. First, let us develop to the utmost our professional side. Let us look out that we occupy such a position that we are not afraid of our assistants. When a man is afraid of his assistants, he belongs in the assistants' place. Let us take an active interest in civic matters and the broad life of the city as a whole. Let us help the young fellow coming into the Engineering Society, both professionally and socially. Remember, it is a long lane that has no guideboard. And then let us socially do everything in our power to get together, to develop our own organization, and to help each other in a way that will not only bring the Cleveland Engineering Society to the front professionally, but as a body of representative citizens of Cleveland. (Applause.)

THE TOASTMASTER:—

Gentlemen, this ends the set program for the evening, and we will close now by singing together two verses of "America". We will sing that standing, and on the conclusion of the song the meeting will stand adjourned.

Singing: "America".

Official Announcement

It is the desire of the Executive Board that the first number of the JOURNAL each year shall contain, so far as possible, the names of the new officials and committees. The lateness of this issue can, therefore, be explained by the following announcement:

Since the annual election (on June 11) of officers and directors, which placed into office the following gentlemen:

DR. R. H. FERNALD, *President*.

MR. A. J. HIMES, C. E., *Vice President*.

MR. F. W. BALLARD, M. S., and MR. E. H. WHITLOCK, M. E., *Directors* (for two years).

The Executive Board, according to the Constitution, filled the remaining offices as follows:

Secretary, DAVID GAEHR.

Treasurer, E. E. RANNEY.

Librarian, G. H. TINKER.

On July 9, 1912, a communication was received from Prof. Fernald, tendering his resignation as President of the Society, on grounds of having been elected to the professorship of mechanical engineering in the University of Pennsylvania.

On July 22, 1912, this was accepted by the Executive Board (in special meeting) with profound regrets, as regards the loss to our Society, yet considered that a high honor has been bestowed on one of our distinguished members and to that extent it viewed the circumstance with justifiable pride.

At a later Board meeting, Mr. W. O. Henderer was elected Vice President.

This necessitated a few changes in the make-up of committees, which now stand appointed as recorded on pages I and II of this JOURNAL.

FROM THE PRESIDENT'S POINT OF VIEW

The man whom you have recently chosen to be your President, Dr. R. H. Fernald, has been favored by fortune with a call to the chair of mechanical engineering in the University of Pennsylvania. We are pleased with this substantial promotion of one of our leading members and I am sure that he takes with him the best wishes of the Society. We rejoice in his success and look forward hopefully to the time when his earnest, conscientious work will receive still higher recognition. But we must turn from this happy contemplation of the good that has come to Dr. Fernald and give thought to the needs of the Society.

The resignation of Dr. Fernald from the presidency has been accepted by the Executive Board and the Vice President has succeeded to that office, in accordance with the constitution. These rapid events have taken your new President unawares and today he is found in the effort to play the part of a leader without having in mind any particular program for the work of the Society. Fortunately its affairs have been so ably conducted during recent years that we are now sailing swiftly along on the rising tide of prosperity. Even though the incumbency of President Fernald was of such short duration, he was able to render us a signal service in effecting an amicable settlement of the Caxton building claim, and we are now free from all business complications and special problems. If we could only maintain our present position, it is something of which we might well be proud, but while we can rightfully view with complacency the place we hold today, stagnation is unthinkable. Our motto must ever be onward and upward. There is no summit in my horoscope of the Society. There is a spacious field in which to work and an abundance of material. We are rich beyond the dreams of mortal man and our only care is to make good use of the opportunities so abundantly provided. I am reminded of the words of my old friend, Dr. Moore, at the celebration last June of the twenty-fifth anniversary of our graduation from Cornell. A body of sailors were cast adrift upon the sea in an open boat and, when brought near to death through exposure, and thirst, a sail was sighted. It came nearer and when signals could be read, the captain said, "What do you want?" The reply was, "Water," and the captain answered, "Lower your buckets." The sailors did so and drew up from the boundless ocean an abundance of fresh, sweet water. Without knowing where they were, they had been perishing from thirst on the bosom of a mighty river.

The greatest riches are those at hand, waiting to be recognized and used.

At present I have in mind three things that make for the success of our Society. First, as a body of professional men, the rank we hold among our kind throughout the nation will be determined by the character and quality of our papers. It is of the first importance that every effort be made to insure an ample supply of papers of real professional interest. I do not mean abstruse papers that can be read only with difficulty by the few, but clear, full presentations of subjects that are close to our lives. Things we want to know, things we need to know, and things we must know. Last year it was my good fortune as chairman of the Publication Committee to observe how systematically and thoroughly the chairman of the Program Committee, Mr. Herron, had arranged for papers to be presented throughout the year, and it was in recognition of this good service that Dr. Fernald continued Mr. Herron at the head of the same committee for the current year. Perhaps it will violate no confidence to say that he has in mind an even better program for the current year.

I would mention secondly the opportunity we hold to shape local practice in engineering affairs and, in so doing, to elevate the tone of public works and raise the esteem of the whole com-

munity for the engineering profession. Ours is still a young profession and the credit it receives for its achievements is much less than what is due. A change is coming. Already the work of the engineer has found a place in fiction, in poetry and in history, and I hope to see the day when the glory of engineering triumphs in the arts of peace will excel in popular esteem the most heroic deeds of war.

The recent action of the Society in recommending to the Mayor and City Council a thorough investigation of the local water supply, before undertaking any precipitate action involving huge expenditures, is itself ample justification for the unusual efforts put forth during the past two years.

Thirdly, I would stimulate the use of every opportunity to further the individual interests of the members. Altruism has not yet become so popular that large numbers of men can be expected to give freely to its service. There must be a personal interest and it is right that such an interest should exist. Every member of the Society has a right to feel at the end of the year that he has personally profited by his membership. In furtherance of this end it is my desire that the current year may be distinguished by a serious and persistent effort to develop in the Society a fraternal spirit, a spirit of sociability and helpfulness. Let each member wear constantly the Society emblem and let each and every member feel free to address in a spirit of friendship any wearer of such emblem. It is my belief that the development of this fraternal spirit is necessarily the first and most important step in the development of a strong, enthusiastic and stable organization, and I charge all committeemen and all officers of the Society with this, their first duty to be brothers to their fellow members.

If these things are held in mind, if each member tries throughout the year to carry out their spirit in some degree, however small, the future of the Society is assured. Do not pin your faith to a single supreme effort. Expect to work, steadily, earnestly, hopefully, and oftentimes against adverse conditions. But keep on working. There is no failure for earnest, intelligent and conscientious effort. The first result is either a success or a guide to future triumph.

FROM THE SECRETARY'S POINT OF VIEW

On two previous occasions, your new Secretary has successfully dodged the harness of this office and then imagined himself as being considered in the class of those "fallen from grace" and immune to further expressions of confidence, like the selection for such an important place in the administration of our Society's affairs, as the secretaryship.

Nevertheless, the third call came, and was presented by one thoroughly familiar with the personal considerations, which seemed to present an obstacle justly demanding attention even now, but which appeared as unsurmountable on previous occasions. The

urgency of the call, either through its intimidating effect or through its coercing appeal to the loyalty to our Society, resulted in a decision to at least make the effort to fill, for a time, the place so ably occupied in former administrations.

However, it is with distinct reluctance that the undersigned presumes to serve the Society as Secretary, and, if there is one thing more than any other which he covets in that connection, it is:

The encouragement of prompt and cordial response to official communications sent out relative to Society Activities, whether printed or personally written.

There is also a business side of our Society life, which, if underestimated or overlooked by members, means extra work for the Secretary in the form of repetition of requests, notices, statements, etc.

Let everyone do his part to reduce this useless drain on our time and treasury to a minimum.

Secondly: Let everyone feel free to offer suggestions for the good of the cause.

Yours, for the interests of our Society,

DAVID GAEHR, *Secretary.*

Reports of Committees

REPORT OF THE COMMITTEE ON TECHNICAL EDUCATION IN CLEVELAND

The Committee on Technical Education in Cleveland have thought best to first learn what is now being done in that direction as a preface to future study and action. To that end two sub-committees were appointed—one to learn what technical study was being done in our factories and shops, the other what study along technical lines was now being done in our schools. The faithful work of these sub-committees is attested by their reports, which follow.

The vision which your committee has of its field of service does not end here. We feel that this Society has a duty to perform to the young seeking technical efficiency and ours should be the pleasure and privilege to aid the younger generation and so benefit our city and our time.

WILLARD BEAMAN, *Chairman.*

REPORT OF SUB-COMMITTEE TO INVESTIGATE EDUCATIONAL WORK AS APPLIED TO MANU- FACTURING COMPANIES AND INSTITUTES AL- LIED THERETO

The appointment of a committee of this kind was due to a feeling founded upon a general, but very uncorrelated knowledge of the educational needs as they exist today among the employees of our manufacturing and industrial concerns. The cry for skilled workmen is heard on every hand; men are wanted who can do things; who have the initiative, and who must needs have more education than is possessed by ordinary mechanics. The extremely rapid strides made in the past few years in manufacturing methods, in machinery equipment, processes employed, and in the high character of the product turned out, have not been accompanied by a corresponding improvement in the skill and mental condition of the workmen. In many cases the processes employed have, to a large extent, been responsible for this state of affairs. Specialization is common where piece-work and reproductive methods are generally employed, which must necessarily be the case in plants manufacturing standard products. Specialization is detrimental to the development of all-around mechanics, men

who not only have mechanical skill, but who have quick, active brains trained for independent action and capable of grasping new problems.

This Society feels that a careful study of present conditions in this vicinity, and the reason therefor may lead to an avenue of endeavor wherein the Society can be of service, not only to the manufacturing companies, but more especially to the employees by using the Society's influence to secure better educational advantages.

Our committee had personal knowledge that a number of the companies in this section were doing practically nothing along educational lines for the benefit of their employes, and to discover where manufacturers are engaged in educational work, it was thought best to send a circular letter to a number of the larger companies with a request for the desired information. The nature of the information sought is given below in an extract from the circular letter before referred to:—

“The Cleveland Engineering Society is making a special effort to ascertain what is being done along educational lines, especially of a technical nature, in our schools and by the various manufacturing concerns of the city.

This committee has been instructed to investigate particularly the educational work which is being done for the benefit of all classes of employes in our shops and factories—also those employed in offices, such as general office help, draftsmen, etc.

With this brief explanation of the nature of the work undertaken by this committee, we earnestly solicit your co-operation in furnishing us the following information:

(1) Is your company doing anything directly or indirectly to educate your employes?

(2) If so, what is the nature of such work?

(3) How long has your company been interested in this work?

(4) Have the results been satisfactory from the company's standpoint?

(5) Are your employes doing anything to educate themselves either by attendance at night school or by organized classes among themselves?

Hoping you will be able to furnish us with the information as above, we are,”

By letter and personal interviews we made an attempt to get in touch with about fifty of the more important manufacturing companies of this section. We succeeded in getting replies to about twenty with the following results.

Only three were carrying on what might be called a fairly complete and comprehensive system of education. Five reported that they were doing nothing along education lines, but were educating some of their employes so as to make them more efficient in producing and handling their own particular product.

Ten reported that they were doing nothing whatever to educate their employes. Three reported that they were educating some of their employes in co-operation with the Y. M. C. A. apprentice school.

Many of the replies received contained much information of value to the Committee. Some had tried various experiments along educational lines, and reported that these attempts as far as the company was concerned were considered failures. Others reported that they were in sympathy with the general educational movement for the benefit of employees and would be glad to co-operate, but did not feel that conditions would warrant their undertaking the maintenance of educational departments in their own plants. About six of those heard from reported that they were employing apprentices. There seemed to be no general agreement as to the practicability of the apprentice system. Even some of those who reported employing apprentices, made the assertion, that they did not think it a paying investment, but that they were obliged, by force of circumstances, to take a few apprentices. Others felt that the failure of the apprenticeship system today was due largely to the shop methods in vogue in many of the large plants, especially in the automobile industry. "The tendency for boys and young men to specialize through the inducement of higher wages offered by automobile manufacturers for a small amount of experience, has had a demoralizing influence on the apprentice system of concerns teaching boys the all-around trades, such as machinists, etc., for the reason that the rate of wages paid to machine operators for doing reproductive work, would be prohibitive in the shops where more experience is required and the practice of specialization is impossible, and competition more severe."

There were others who claimed that the apprentice system worked out quite satisfactorily to the companies in their particular lines.

From the information gained as above, we had no difficulty in deciding upon what companies to visit in order to personally study the educational methods employed and the results obtained. Accordingly, the committee made personal visits to the following: The Warner & Swasey plant, the Lake Shore & Michigan Southern Shops at Collinwood, the Y. M. C. A. school and the Mill Continuation School. A general summary report of each of the above is given below.

DATA REGARDING THE WARNER & SWASEY COMPANY APPRENTICESHIP SCHOOL.

The first session was held at 8 A. M., Monday, November 6, 1911.

The school opened with 44 students, divided into four classes of nine students each, and one class of eight.

Three classes are taking Freshmen work consisting of English, Arithmetic and Drawing.

Two classes are taking Sophomore work consisting of English, Algebra, Descriptive Geometry and Drawing.

The following additional studies will be taught in the third and fourth years: Business English, Trigonometry, Physics, Chemistry, Drawing, Machine Design, Mechanics and Civics.

Recitation periods are held daily Monday to Friday, inclusive, from 8 to 10 A. M. and 12 to 2 P. M., each boy attending twice a week, the company paying him his regular wages for school hours.

Lectures on cultural and related subjects are given at least once a month in the evening without cost.

A complete stereopticon for various kinds of projection is used regularly for instruction purposes, the school room being equipped to darken in day time.

The students entering upon the apprenticeship course do not begin work in the school, although employed in the factory, until the beginning of the new term following their entrance into the company's employ.

A branch of the Public Library is maintained in connection with the school both for reference in the school work and for general reading for shop men.

In addition to the school, there is a club life for apprentices, managed by themselves under direction of our superintendent's office, which provides social, athletic and other stunts, helping the apprentices to appreciate the importance of knowing how to get along in a friendly way with other associates. This will be of importance both to them and the company in the years to come, as these trained men are put into places of responsibility.

The principal of the school is Mr. C. H. Owen, a man in our organization for the past two years; a Cornell and Case School graduate and a military-schooled man. His associate, who looks after the office work chiefly, with occasional teaching, is a Technical School graduate.

THE L. S. & M. S. APPRENTICE SCHOOL AT COLLINWOOD.

At Collinwood, in the general repair shops of the Lake Shore R. R., the Committee found a very live school. The Assistant Master Mechanic, Mr. M. D. Franey, seemed to have the organization very much at heart and explained its working together with Mr. Cross, who came in later.

It seems that the company, feeling the need of better trained men, engaged Mr. Cross to establish apprentice schools at a number of their shops and to generally supervise them. At present, they are being carried on in six of the company's shops, all very successfully.

The Collinwood shops employ some 60 to 70 apprentices, who are carefully selected as to their probable capability to learn, and who are even required to undergo a physical examination, for the company wishes none but healthy and able-bodied young men. There seemed to be considerable variation in ages, but all

appeared to be under 20. Parental co-operation is not requested except in special cases.

The boys are assigned to foremen as apprentices, for machine work, smithing, boiler-making, pattern-making, etc., as the case may be, and divided up into three classes. Each class meets for two hours, on two mornings each week, precisely from seven until nine, under a special instructor, where they study arithmetic, sketching, mechanical drawing and elementary mechanics, each boy in the class being given work suited to his development.

One-half of the room is fitted up as a mechanical laboratory, with sectional models of different railway appliances, as well as a motor air-compressor, and a complete steam engine, which can be operated by the compressor. Here, too, is grouped apparatus for practically demonstrating simple problems in weights, levers and the simpler formulae of physics.

The boys are gradually carried through these things for four years and are graduated to their special trades with a diploma signed by the higher officials.

The discipline of the school appeared perfect, the session closed exactly on the hour—each lad put away his board and drawing materials as he filed out in line past a tier of numbered shelves. The whole class tools were gathered up, put away and locked with one lock in an incredibly short time, and the boys reported immediately to their foremen.

The boys take to the school like a fish to the water, and there is no question about the value of the school to them. No loafing is possible. They are taught to use their minds. Problems are given out for home work, and if a boy fails to turn them in, he is put on the carpet before the officials of the shop, and if the offense continues, is discharged.

In our minds, after an hour's talk with the men in charge, there was no doubt as to the practical benefit accruing to the company.

First:—It tends toward establishing the much sought for *esprit de corps* in a large body of men and must continue to do so as the school grows older. We all know this is valuable—we only cannot estimate its value.

Second:—It gives the company, young men who are trained to use their minds on railroad problems. Young men who have a teachable spirit, rather than the average lot of rowdies.

Third:—It gives them young men, any one of whom is capable of performing a large variety of tasks well, instead of the usual limitations. This rotation of work is insisted on in the shop, and is watched by the special instructor.

Fourth:—It gives them an always available productive staff, who can be sent out on a repair job, who can make the necessary sketches, make patterns, do the machining, and do the necessary calculating, without carrying a heavy overhead in this particular. They are also competent to run off tests and submit complete reports.

We asked about desertions, and while admitting that they were paying something out for the benefit of railway equipment companies, and rival roads, the officials maintained that these men

who left them still contributed to general railway efficiency and hence they still received benefit. They also stated that the percentage of desertions was very small.

The surest indication that the company believes the school is a paying proposition is its extension of the system after a test of years.

We firmly believe that where any institution employs a large number of boys, say more than 50, where the work to be done calls for intelligence rather than automatic moving, and where the tasks are of varying nature with many possible promotions, there can be no doubt as to the possible profit of such a school. With any of these conditions absent, the financial profit to the company is problematical, although the commonwealth is being benefited.

In conclusion, we especially wish to thank Mr. Franey, the assistant master mechanic at Collinwood, and Mr. Cross, the school supervisor, for the courtesy shown us.

Y. M. C. A. CO-OPERATIVE APPRENTICE SCHOOL.

Students enrolled, 85.

Firms enrolled, 15.

Each student spends four hours per week at school and the company employing him pays him his regular wages while in attendance at school. The company pays the Y. M. C. A. \$20 per man for 40 weeks of school work to cover tuition.

The Object.

Every community must work out that scheme of industrial education which will most efficiently meet the needs of local conditions. Some organization must pioneer such work and the Young Men's Christian Association through its Educational Department is prepared to work with the manufacturers of Cleveland in promoting a day co-operative school for apprentices.

The Committee.

In such a co-operative school an advisory committee of experienced practical men is necessary to legislate regarding methods of instruction, to select instructors and equipment, to prevent wasteful methods of education and finance.

The following representative manufacturers have consented to serve as such an Advisory Board: Mr. W. D. Sayle, Chairman, Cleveland Punch & Shear Works Co.; Mr. Robert Wuest, National Metal Trades Association; Mr. C. B. Wilson, Ferro Machine & Foundry Co.; Mr. Jno. H. Hertner, Rauch & Lang Carriage Co.

The Method.

Each apprentice enrolled by a company comes to the school for one-half day—four hours—each week.

Schedules are arranged so that no department in a factory is drained of boys at one time. Boys are paid their usual wages for attendance and are docked when absent or late. A weekly report

is made from the school to the employers in time for their payrolls. For each boy enrolled in the school the company pays to the Young Men's Christian Association twenty dollars to cover tuition for a term of forty weeks.

Synopsis of Instruction.

First year:—Shop Arithmetic, Spelling, Reading, Composition, Reading Blueprints, Mechanical Drawing, Geographical Relations of Shop Materials, Civics.

Second year:—Objective Geometry, Science—Iron, its manufacture and founding, Blueprints, Sketching, Shop Practice.

Third year:—Geometry and Algebra, Science—Physics, Shop Practice, Foreman's Question Box, Drawing, Civic and Economic History and Literature.

Fourth year:—Trigonometry and Applied Mechanics, Science—Shop Chemistry, Shop Practice and Management, Visiting Industrial Plants and Discussion based on observations of waste and system. Culture—The man as a wage-earner and citizen.

Do the Young Men APPRECIATE an Opportunity?

A Brief Report of the Educational Department of the Cleveland Young Men's Christian Association for the year April 1, 1911, to March 31, 1912.

Summary.

Total number of different students in classes in the building	1,121
Total number of different students outside the building—	
English for Foreigners.....	466
Number of men giving entire time to teaching.....	5
Number of part time teachers.....	26
Number of men, not teachers, giving entire time to supervision	2
Number of subjects taught day and evening.....	37
Business and professional men, who gave talks and lectures	44
Total expenditures	\$22,932.60
Total income	22,731.46

Of this total income all but \$1,043 was paid by the students.

Items by Departments.

Evening School:—	
Total number of students.....	690
Number of different classes meeting regularly.....	32
Day School:—	
Total number of students.....	213
Number of different subjects taught.....	27
Co-Operative Apprentice School (half day per week plan):—	
Number of manufacturers represented.....	15
Number of different students.....	89
Accountancy School (Evening):—	
Number of different students.....	129
Number of weekly sessions.....	6

English for Foreigners (outside the building) :—

Number of different classes started.....	14
Number of different students in classes.....	466
Practical Talks (not included in regular class schedule)...	18
Attendance at same (not including students).....	3,454

REPORT OF CONTINUATION SCHOOL, DISTRICT No. 12,
MILL BUILDING, CLEVELAND, O.

Children, desiring to leave school, between the ages of 14 and 16, having completed the Fifth Grade, but without Certificates of Eighth Grade Graduation, apply at the Attendance Department of the Board of Education. Here they are granted a *Contract Permit*, which requires the signature of the employer, who thereby agrees to allow said minor to attend school *six hours* of each week of the school year.

The contract remains in the possession of the employer until said minor changes his position, in which case the contract is returned to the Department, and a second contract issued.

Copies are also filed.

Several changes made by one minor demands investigation.

Cards of Notification are sent out from the Department to the teachers of Continuation Schools in the districts in which the minors reside.

If for plausible reason another school is preferred, a transfer is readily granted by the Educational Department.

In my own case, as soon as cards were received personal calls were made. When numbers made this impossible, letters were written, the aim being to assure the pupil of our kindly interest.

Many pupils responded willingly, eagerly; others, fearful of the law, came with a determination to make somebody suffer for their discomfort.

To children, untutored and unskilled, comes the same thought of tyranny and oppression that ignorance fosters in the hearts of their elders.

Human nature cannot long resist sunshine and a genial atmosphere harbors no antagonism. Each day brought new faces, and yet the problem of each pupil's need was much the same.

History and Geography appealed to most pupils at once, for they lost themselves in their interest for novelty; and the remarkable events, the evolution of time and tide in the affairs of man awakened their interest and gave to these boys and girls their first broad human views of life.

The school room must needs fit the youth of our country, above all, for *sensible, reliable citizens*. The teacher must be neither policeman nor animal trainer, but rather a companionable inspiration.

Dramatization of historical characters and events—the pass-

ing of ships on commercial voyages—the exchanging of goods in far distant marts—“Uncle Sam’s” entertainment of the nations of the world—visiting the Stock Exchange—reaping harvests—logging in the northwest—dramatization of these awoke in the children a desire to express their own crude ideas; to talk of what each felt—of character—of honor—of effort.

After such expression, the teacher was conscious of the vulnerable point of attack. Each pupil of no phenomenal sort was found to have one marked ability. A bit of encouragement seemed often to be watered and electrified by magic.

Written English was approached by means of request for position; answers to advertisements; invitations; letters; etc.

The personal deficiencies of pupils made them realize that knowledge of letter-forms and spelling was absolute.

The drudgery of memorizing rules for Grammar was minimized. Sentences containing blanks were filled and reasons given for choice of words.

Children coming from some Parochial Schools could neither cipher, spell, nor read English. These received individual instruction while classes gave their attention to written work.

Arithmetic took practical form. (a) Fundamental operations with integers and fractions. (b) Terms employed in commercial and industrial activities. (c) Itemizing bills. (d) Quick mental combinations and results required in shop and store.

Classes were formed of pupils interested in one line of work, and difficulties they met presented. *e. g.* Boys working in the same department of a shop. Some at piece-work; others at day-work. Who earned more? Why? Why were they shifted? How did they take the test? Why was one promoted? etc. New view points were taken—often resulting in a practical and pleasant attitude toward each other and their employer.

The available reading matter was far too difficult. Even after analysis and explanation a small degree of success was reached.

Magazines, supplied at the teacher’s expense, furnished good reading for the advanced, while the illustrations afforded conversation lessons for all.

Daily instruction in Hygiene and Ethics had instant effect.

There is always profit in academic work, but active boys and girls require the recreation that comes only through physical activity. *Judgment, precision, dexterity* are the result of manual training.

The fault of strenuous academic training has turned too many of our vigorous youths and maidens into the workshops unequipped.

The country needs today, as never before, the mechanic—the skilled artisan.

Let us comprehend fully the meaning of the great Froebel’s theory:

“We must teach the child so that when he becomes capable of productive activity, the objects he produces may have real worth.”

Scissors were the only implements at hand. They were use-

ful in fashioning stencils for decoration. The pupils were encouraged to paint their rooms at home, applying stencils as border designs. Correct colorings were urged.

Figures in Mensuration were cut and problems evolved.

Poor "rulers" were a drawback, but unit drawings furnished additional problems in fractions.

Lack of blackboard space hampered the work throughout.

Late in the year the Education Department found it convenient to furnish one assistant and one special Domestic Art instructor. The girls were taught to sew, the boys to handle a knife. In four weeks, each of the 109 girls had made an apron, while each of the 106 boys had a finished match safe. "By their works ye shall know them."

A vote last week (May 6-10, 1912) was taken. The questions involved were:

(1) Shall we spend \$1,000,000 for playgrounds?

(2) Shall we spend \$1,000,000 for a free work shop?

Both boys and girls cast ballots as on an election.

The result of the 215 ballots was:

Playgrounds—No, 212; Yes, 3.

Work shop—No, 3; Yes, 212.

A vote during April showed of the 200 votes cast:—

One hundred and ten desired a summer session of Continuation School.

Twenty-five expressed no opposition.

Sixty-five opposed.

Mill Continuation School is closing its first short year of 34 weeks. The school has succeeded in spite of opposition by press, parents and courts. No employer represented but has been helpful.

Bear in mind, too, that 96 per cent of the boys and girls suffer the loss of six hours pay each week.

Since Sept. 12, 1911, we have:—

Registered—Boys, 116; girls, 113; total, 229.

Belonging—Boys, 107; girls, 108; total, 215.

Average *daily* absence, 4.

Average daily tardiness, 0.2.

Total truants, 14.

An exhibition of work was held the evening of May 16, 1912, in the auditorium of the building, to which all the pupils and a limited number of guests were invited. We refer you to Mr. Warren E. Hicks and Mr. Charles Orr, for statement of its success.

The Continuation School has been a personal problem and has been successfully solved at Mill building, with the helpful advice of Assistant Superintendent Mr. Warren E. Hicks and the Principal, Mrs. Emma R. Hinckley, and the hearty co-operation of my co-workers, Mrs. Sadie Rigelhaupt and Miss Blanche Kane.

My plan for the useful continuation of this School is to equip buildings as Vocational Centers with a six-hour day devoted as follows:

ACADEMIC:—*One Hour*—(a) Arithmetic; (b) Geography; (c) History; (d) Spelling; (e) English.

COMMERCIAL:—*One Hour*—(a) Arithmetic; (b) Letter-writing; (c) Business Forms; (d) Book-keeping; (e) Stenography.

PHYSICAL:—*One Hour*—(a) Ethics; (b) Deportment; (c) Games; (d) Development; (e) Hygiene.

VOCATIONAL:—*Three Hours*—(a) Housework (domestic science); (b) Sewing (domestic art); (c) Clerking; (d) Specific vocational training.

These schools should be in close relation to employers and their needs; visited, under direction, by men and women interested in boys and girls; controlled by the best in the teaching force of a community; and given a special supervisor of positive ideas, broad sympathies, and rare good judgment.

Respectfully submitted,

GRACE E. MAKEPEACE.

May 22, 1912.

As a result of the information given above, we have in a general way arrived at the following conclusions:

That there is a demand for better educated workmen; that such education is a paying investment; that the manufacturer should be consulted and have a voice in the selection of the proper course of study to be pursued, and to be given general supervision in the operation of the school; that education not only accomplishes the purpose of developing more efficient workmen, but produces a live, wide awake, intelligent, resourceful, broad-minded type of citizen, men capable of independent thinking, making toward better living and general well being.

We do not believe that the apprenticeship system can be applied to all manufacturing concerns with equal efficiency, in fact, it is felt that some companies would find it a very unprofitable undertaking. This would depend largely upon location, size of company, kind of product and method of manufacture.

As to the course of study to be pursued and the teaching method to be employed, there seems to be quite a wide difference of opinion. Some advocate confining the course of study to the more elementary subjects, such as reading, writing, spelling, English and arithmetic. Others believe that the proper course should include in addition to the above, algebra, geometry, trigonometry, and practical mechanics, so that those that have the ability and mental grasp may have the opportunity to rise above the plane of mere mechanics. It is felt by some that night school work can be made to answer all the demands necessary and quite sufficient for the needs of the manufacturer. The great majority, however, and the sentiment is growing rapidly, hold that where all sides of the question are considered, the most feasible and regular method of instruction is in the main like the plan adopted by the Y. M. C. A. co-operative apprentice course, as outlined above. This method, as can readily be seen, is about the same as employed

in the Warner & Swasey and the Lake Shore & Michigan Southern schools, differing in that the Y. M. C. A. takes care of the cultural and scientific studies and the manufacturing concerns look after the development of the skill of the workmen in shop practice, in place of the company doing both.

In conclusion, we believe that the Cleveland Engineering Society could render invaluable service in this field by lending its assistance and advice in inducing those of the large companies to conduct schools of their own, where such methods of instruction are feasible. The Society can also endeavor to point out to the smaller and special industries, unable to support their own schools, the advantages of co-operating with some educational institution where the cultural and scientific studies can be taught. To assist in establishing schools that would fill this want would be doing a creditable and extremely useful work on the part of the Society. We would not only be helping to satisfy a demand for a more intelligent class of workmen, but we would be helping to develop men who have sufficient education to give them a broader mental grasp of life, enlarging their possibilities, rendering them capable of independent action and thinking, and in general making for a larger and better citizenship.

GEO. F. BURROWS, *Chairman.*

F. A. SCOTT.

F. R. WALKER.

REPORT OF THE SUB-COMMITTEE ON TECHNICAL EDUCATION IN THE SCHOOLS OF CLEVELAND

There appears to be some confusion of thought in the popular use of the word "technical", as applied to education, and in order that we may keep clearly in mind certain distinctions in the current use of several terms descriptive of educational work, the following definitive statement is presented for reference. In general, the schools included in the term Industrial are of three classes, namely, manual training schools, trade schools, and technical schools.

The manual training school in its simplest form is purely cultural, the purpose being the harmonious development of the faculties.

In the trade school in its simplest form the instruction is confined to the workshop and consists in perfecting the pupil in the practice of the manipulations and operations of skilled workmen at particular trades and the primary aim is to give the pupil a thorough practical knowledge of some handicraft.

In the technical school in its simplest form the instruction is supplementary to the work of the trade school and is limited chiefly to the school room or the laboratory and consists in only

such use of tools and machinery by the instructor as will clearly illustrate the application of the scientific teaching. Many such schools in Europe and the United States make no provision for the use of tools and machines on the part of the pupil. The purpose of the instruction is to give the student an understanding of the scientific principles involved in the work that he may be called upon to do at his trade and to so increase his intelligence generally that he will be better prepared for rapid advancement to positions of responsibility.

In practice the three classes of schools do not generally confine themselves rigidly to the foregoing definitions, but partake somewhat of the nature of one of the other classes. Sometimes it is very difficult to designate the class to which a particular school properly belongs.

It may be further stated that according to the broad meaning of the term, schools of law, medicine, surgery, music and of other subjects are technical, but although many such are to be found in Cleveland, they are not included within the restricted use of the word in educational matters and are not considered to be within the scope of the work assigned to this committee.

The introduction and early development of manual training in Cleveland was described by Mr. W. E. Roberts in *The Plain Dealer* of May 22, 1902, as follows: "Manual training in Cleve-

HISTORY AND PRESENT STATUS land, so far as known, begins with a little school, started in a barn situated on Kennard street, near Euclid avenue, for the benefit of the boys in the Central High School. The school was organized in February, 1885, by Mr. Newton M. Anderson, an instructor in the high school, who firmly believed in the value of manual training as an educational factor. The enthusiasm of the boys of the little school soon brought it to the notice of some of the business men of the city, and as a result, the Cleveland Manual Training School Company was incorporated on June 2, 1885, with a capital of \$25,000. The purpose of the company, as stated in its articles of incorporation, was "the promotion of education and especially the establishment and maintenance of a school where pupils shall be taught the use of tools and materials, and instruction shall be given in mechanics, physics, chemistry and mechanical drawing." A new school building, situated on East Prospect street, was completed in January, 1886, and the school opened early in February, with Mr. Anderson as its principal.

Thus far the work was conducted by private enterprise. In his report in August, 1886, President E. A. Schellentrager, of the City Board of Education, says:

"During the past school year several new questions have been agitated in the proceedings of the Board of Education which, in my opinion, deserve further consideration. Of these I would like to mention the proposition looking to the introduction of general systematic instruction in gymnastics and the introduction of industrial education — so-called manual training — into the curriculum of our public schools." President Schellentrager speaks in the highest terms of the Cleveland Manual Training School

and its work, but regrets that, as a private institution with high tuition fees, many who most need this particular branch of training must be excluded, and further regrets that the financial condition of the Board of Education will defer the possibility of the incorporation of manual training as part of the public school work, unless an additional levy be granted the Board of Education by the legislature for this special purpose. This last suggestion seems to have borne fruit, for through the influence of the Boards of Education of 1886 and 1887 a law was passed by the state legislature making possible a levy of one-fifth mill upon taxable property to provide for manual training and domestic training for children of the city schools. The proceeds of this levy were given to the support of the Cleveland Manual Training School and in return free instruction was given to the pupils of the high schools.

In the meantime another movement had been going on which has since become a part of our manual training system. Even earlier than the beginning of the manual training work proper, in 1884, a kitchen garden was opened in one of the basement rooms of Unity Church, where instruction in cooking was given to a small class of girls. In order to extend the usefulness of this work, the Cleveland Domestic Training Association was formed early in 1886. Rooms were opened at 479 Superior street and, by permission of the Board of Education, free classes were formed of pupils from Rockwell School. In September, 1887, the cooking department of the association became a regular branch of the Cleveland Manual Training School and so continued until the close of that school.

The first independent movement of the Board of Education was in 1890, when a manual training school was established in connection with the West High School in response to a demand from the people of the west and south sides. The organization of this school was similar to that of the Cleveland Manual Training School, but, unlike that school, it was directly under the management of the Board of Education and was supported entirely from the tax levy for that purpose. In 1892, the Board of Education withdrew its support from the Cleveland Manual Training School and the Central Manual Training School on Cedar avenue was built and equipped. One year later, under Superintendent Draper, manual training was extended through all the grades of the elementary schools.

Cleveland has no public trade schools.

Technical education in the Cleveland public schools may be said to have had its beginning with the opening of the Technical High School, October 12, 1908.

The public schools now in operation within the city, which may be classed as technical, are:—

The East Technical High School, the West Technical High School, the West High School of Commerce, the East High School of Commerce, Brownell School, Mound School and Mill School.

Case School of Applied Science, an endowed school of higher education, is also within the city and together with the schools above mentioned and the manual training of the graded

schools, affords a continuous line of technical training for the children of Cleveland, from the earliest years of study to adult manhood.

The East Technical High School was the outgrowth of studies of the Educational Commission, a body of representative citizens appointed by the president of the Board of Education

and consisting of the following men:—

EAST TECHNICAL HIGH SCHOOL Messrs. J. G. W. Cowles, Elroy M. Avery, E. M. Baker, J. H. Caswell, Charles Gentsch, Frank Hatfield, Charles S. Howe, F. F. Prentiss, Thomas L. Johnson, C. W. McCormick, James McHenry and Charles F. Thwing.

A thoroughly modern fireproof building has been erected at the corner of East Fifty-fifth street and Scovill avenue and furnished with a very complete equipment for the special needs of such a school.

Extracts from *The Technical High School*, a pamphlet published by the Board of Education, may be made as follows:—

Territory The school is open to students from any district in the city. The long distances from which many students come and the length of the daily session has made it necessary to provide a lunch room, where a warm noon meal may be enjoyed. This service is conducted as nearly as possible on a no-profit basis. At from eight to twelve cents one may obtain a substantial lunch. Pupils may also bring all or part of their luncheon from home, if they so prefer.

Segregation In most classes the nature of the studies and the purposes in view are so different as to demand a separation of the boys from the girls. There is, therefore, organized within the one building a boys' school and a girls' school.

Library This is organized as a branch of the Cleveland Public Library, which furnishes the clerical force, while the Board of Education furnishes the room, light, heat and equipment. The collection consists at present of about 2,000 volumes. The circulating department is supplied from the city library; the reference department, which consists largely of technical works, is furnished by the Board of Education. The library will be open week days and evenings to the general public as well as to the members of the school.

Aims and Methods The Cleveland Technical High School has two immediate ends in view, (1) to prepare youth of both sexes for a definite vocation and for efficient industrial citizenship; (2) to help men and women already engaged in a vocation to better their condition by increasing their technical knowledge and skill. To such as may desire to pursue their studies still further it also offers the opportunity to prepare for entrance to technical schools of college rank.

The School Year The school is in session the year round. The year is divided into four quarters of twelve weeks each, with one week between the quar-

ters. By thus eliminating the long summer vacation, a saving of an entire year in the usual high school course is made possible. This is of great advantage to the student who, for any reason, may wish to secure a maximum of education in a minimum of time. Those who do not wish to avail themselves of this advantage or whose physical condition does not permit the strain of continuous study, still have the opportunity of devoting four full years to their high school course.

The plan of a continuous session broken up into short terms is also of advantage to the student who, from any cause, fails in some part of his work, since by these frequent opportunities for re-adjustment he is given a chance to "catch step" again and go on with his work in a new class with comparatively little loss of time.

Owing to the crowded condition of the East Technical High School, which during 1911 and 1912 enrolled about 1,800 pupils, a similar school on West Ninety-third street and Willard avenue was opened in March, 1912. Three hundred pupils were transferred from the East Technical to the West Technical High School at this time. The course of instruction is the same as in the original Technical High School, as given above.

There is now some uncertainty concerning the work of the schools during the summer months because of a recent change in the plan of promotion in the public schools. A method of quarterly promotion had been established which was well calculated to facilitate the work of the summer session. This has now been changed to a scheme of semi-annual promotion, the merits of which have not yet been demonstrated.

The West High School of Commerce, like the East Technical High School, was the outgrowth of the work of the Educational Commission. It was opened for the admission of students October 4, 1909. A special advisory committee was appointed at that time to care for the interests of the school, the membership of which was as follows: Charles S. Howe, chairman; George S. Adams, George W. Avery, Charles E. Adams, Erwin L. Fisher, Evan H. Hopkins, S. H. Halle, Munson A. Havens, W. S. Hayden, John G. Jennings, George W. Kinney, William G. Leopold, F. W. Lothman, Charles E. J. Lang, Rev. F. T. Moran, D. D., L. F. Mellen, Malcolm McBride, D. E. McLean, C. W. McCormick, Harry New, treasurer; C. A. Nesbitt, Stephen L. Pierce, F. F. Prentiss, George A. Rudd, Col. J. J. Sullivan, L. H. Treadway, G. A. Tinnerman, Thomas H. Wilson, C. A. Vogt, C. G. Watkins.

The present membership of the committee is as follows:

F. F. Prentiss, chairman; Chas. E. Adams, O. J. Fish, E. W. Fisher, H. E. Hackenberg, S. H. Halle, Munson A. Havens, W. S. Hayden, Chas. S. Howe, John G. Jennings, George W. Kinney, William G. Leopold, Bascom Little, Malcolm L. McBride, David E. McLean, Harry New, Chas. A. Nesbitt, Stephen L. Pierce, George A. Rudd, Lyman H. Treadway.

The school, at present, occupies the old Normal School building, formerly the West High School, at the corner of Bridge avenue and Randall road. A pamphlet entitled *The High School of Commerce*, published by the Board of Education, contains the following statements of

The Aim of the School In the High School of Commerce, the application of the subjects studied to business pursuits is constantly kept in mind. The school relates itself to the business community and has the co-operation of the business men of the city.

The establishment of the school is the result of a demand on the part of business men for a more adequate and specific training of those who go direct from the high school to the offices or the store.

An advisory committee of thirty business men of the city appointed by the Board of Education has co-operated in the preparation of the course of study. In the course emphasis is placed upon subjects believed to be of the most value to the young man or the young woman, who is employed in mercantile pursuits.

The course as outlined seeks to emphasize the subjects wherein the average boy is found to be weak even though these subjects be elementary in character. Hence, the fundamental subjects of spelling, penmanship, and arithmetic, ordinarily laid aside at the close of the grammar school, find place in the High School course along with the more advanced work in English, Book-keeping and Mathematics.

While the student is extending his knowledge of academic and technical subjects, he is not allowed to forget how to spell, to write and to add. By daily practice, his skill in these essentials will constantly increase while he is acquiring an ever-widening knowledge of more advanced subjects. The school does not seek to prepare for college, and obviously it has more time to devote to such subjects as best prepare for the life-work of its students. Incidentally, the course offers an unusually good preparation for Normal School for young ladies, inasmuch as the subjects on which special emphasis is laid are those which they will be called upon later to teach. Likewise the course offers an excellent preparation for advanced work in economics, commerce, and business organization.

Ohio State University has placed the High School of Commerce on the accredited list as a result of the examination of the work of the school extending over several days.

All subjects, both academic and technical, are carefully correlated so that each supplements the other. Each department in the school knows what is being done in the other departments and relates its work so as to prepare for that which is yet to be taken up or to be continued.

While the aim sought is one of practical preparation for life, the discipline that comes from hard and systematic study directed along these lines can be of no less value as an educative agency than that of other subjects pursued alone for culture's sake. To develop the power to think and to reason is as earnestly sought as is speed and accuracy in execution.

It is not too much to expect that graduates of this school will have an intelligent appreciation of the principles of trade, some conception of the dignity and importance of commerce, and above all, have a just notion of the ethics of business. We aim to impress upon the student that his employer's interests are his interests, that he best serves himself by being thoroughly loyal to his employer, and that the highest success a business man or business firm can attain is a reputation for honest goods and fair dealing.

Like the Technical High School, it is open to students from all sections of the city and is provided with a lunch room for the benefit of those coming from long distances.

The enrollment at the opening of the school was 426. At the present time (report of April 12, 1912) it is 704. The Bridge avenue building, as originally built for the West High School, was

*EAST HIGH SCHOOL
OF COMMERCE*

intended to accommodate about 350 pupils, less than the entering class of the High School of Commerce. To relieve the crowding an East Branch was started in and now occupies an old frame, eight-room building, formerly used by the Rosedale grammar school, at which 142 pupils attend, leaving 562 at the Bridge avenue building.

Other Public Schools

Elementary industrial education is in operation at Brownell School, Mound School and Mill School. Their aim is to meet certain special needs and the success so far attained has been most gratifying. A detailed account of the work may be found on pages 36-39 of the Annual Report of the Superintendent of Schools for 1909-1910.

The account of the Technical Schools of Cleveland naturally culminates in the Case School of Applied Science. This is an endowed college, providing thorough and practical instruction

*CASE SCHOOL OF
APPLIED SCIENCE*

to a limited number of students in Civil Engineering, Mechanical Engineering, Electrical Engineering, Physics, Chemistry and allied subjects. Applicants for admission must be at least seventeen years of age and present satisfactory evidence of adequate preparation. Each course requires four years for completion and leads to the degree of Bachelor of Science. The Master's degree is conferred after at least one year of satisfactory graduate work. Research work is encouraged.

Instruction is given by lectures and recitations, laboratory, field and shop work, and by regular excursions to manufacturing plants and works of engineering. The laboratories and shops of the several departments are thoroughly equipped with proper apparatus and machinery affording excellent facilities for practical work. As part of the large amount of apparatus provided there may be mentioned the Hough Printing Chronograph in the Mathematical and Astronomical Department, which records time to the hundredth part of a second, and a complete milling and concentrating plant in the Mining Department, of sufficient size to handle several tons of ore.

This college is not in any way connected with the public school system of the city. A tuition fee of \$125 per year is charged. Laboratory fees and other incidentals may be as much more. The attendance is between five and six hundred men.

A comparative statement of all High School courses of Cleveland is herewith submitted.

HIGH SCHOOL COURSES COMPARED

ACADEMIC—COMMERCE--TECHNICAL

FIRST YEAR

CLASSICAL:—English, 5; Algebra, 5; English, History or German, 5; Latin, 5; Physical Training, 2; Music, 1.

SCIENTIFIC:—English, 5; Algebra, 5; Natural History or English History or Manual Training or Bookkeeping or Applied Arts, 5; Latin or German, 5; Physical Training, 2; Music, 1.

COMMERCE, BOYS:—English, 5; Algebra and Arithmetic, 5; Commercial Geography, 5; Applied Arts, 5; Penmanship and Business Forms, 5; Physical Training, 2; Music, 1.

COMMERCE, GIRLS:—English, 5; Algebra and Arithmetic, 5; Botany and Physiology, 5; Applied Arts, 5; Penmanship and Business Forms, 5; Physical Training, 2; Music, 1.

TECHNICAL, BOYS:—English, 5; Mathematics, 5; Industrial Geography, 5; Wood-Working, Turning, Cabinet-Making, 5; Mechanical Drawing, 3; Physical Training, 2; Music, 1.

TECHNICAL, GIRLS:—English, 5; Mathematics, 5; Botany and Physiology, 5; Applied Arts, 3; Cooking, 3; Sewing, 2; Physical Training, 2; Music, 1.

SECOND YEAR

CLASSICAL:—English, 5; Geometry, 5; German or Greek, 5; Latin, 5; Physical Training, 2; Music, 1.

SCIENTIFIC:—English, 5; Geometry, 5; Physical Geography or Manual Training or Bookkeeping or Applied Arts, 5; German or Latin, 5; Physical Training, 2; Music, 1.

COMMERCE, BOYS:—English, 5; Geometry and Arithmetic, 5; History or Commerce, 5; Applied Arts, 5; Penmanship and Bookkeeping, 5; Physical Training, 2; Music, 1.

COMMERCE, GIRLS:—English, 5; Geometry and Arithmetic, 5; Commercial Geography, 5; Applied Arts, 5; Penmanship and Bookkeeping, 5; Physical Training, 2; Music, 1.

TECHNICAL, BOYS:—English, 5; Mathematics, 5; Chemistry, 5; Mechanical Drawing, 2; Pattern-Making and Foundry Practice Forging, 5; Physical Training, 2; Music, 1.

TECHNICAL, GIRLS:—English, 5; Mathematics, 5; Chemistry, 5; Applied Arts, 5; Cooking, 2; Dress-Making, 3; Physical Training, 2; Music, 1.

THIRD YEAR

CLASSICAL:—English, 5; Mathematics Algebra, 3; Physics, 5, or American History, 5 or 4; German or Greek, 5; Latin, 5; Oratory, 1; Physical Training Optional, 2; Music, 1.

English, 5; Physics, 5, or American History, 5 or 4; German or Greek, 5; Latin, 5; Oratory, 1; Physical Training Optional, 2; Music, 1.

SCIENTIFIC:—English, 5; Mathematics Algebra, 3; Physics, 5; American History, 4; German or Latin, 5; Oratory, 1; Physical Training Optional, 2; Music, 1.

English, 5; Physics, 5; American History, 4; German or Latin, 5; Oratory, 1; Physical Training Optional, 2; Music, 1.

COMMERCE, BOYS:—English, 5; Bookkeeping, Accounting and Arithmetic, 5; Chemistry, 5; American History, Civics, Municipal Activities, 5; German, French, Spanish or Short Hand, 5; Typewriting, 5; Physical Training Optional, 2; Music, 1.

COMMERCE, GIRLS:—English, 5; Bookkeeping, Accounting and Arithmetic, 5; Chemistry Elective, 5; American History, Civics, Municipal Activities, 5; German, French, Spanish, Short Hand or Arts, 5; Typewriting, 5; Physical Training Optional, 2; Music, 1.

TECHNICAL, BOYS:—English, 5; Mechanical Drawing or Machine Shop, 2 or 5; Physics, 6; Industrial History or German or Technical, 5; Technical, 7; Physical Training Optional, 2; Music, 1.

TECHNICAL, GIRLS:—English, 5; European Art History, 5; Physics, 6; German or Technical, 5; Technical, 7; Physical Training Optional, 2; Music, 1.

FOURTH YEAR

CLASSICAL:—College English, 5; Mathematics Geometry, 2; Physics or Chemistry or French, 5; Latin, 5; German or Greek, 5; Physical Training Optional, 2; Music, 1.

College English, 5; Mediaeval or Modern History, 5; Physics or Chemistry or French, 5; Latin, 5; German or Greek, 5; Physical Training Optional, 2; Music, 1.

SCIENTIFIC:—College English, 5; Mathematics Geometry, 2; Mediaeval or Modern History, 5; Chemistry, 5, or Physiology and Botany, 5 or 4; Latin or German, 5; Physical Training Optional, 2; Music, 1.

American Literature, 5; Mediaeval or Modern History or American History or Civics, 5; Chemistry, 5, or Physiology and Botany, 5 or 4; Latin or German, 5; Physical Training Optional, 2; Music, 1.

COMMERCE, BOYS:—English, 5; Banking, Transportation, Business Organization and Cataloging and Salesmanship, 5; Economics, Commercial Law and Local Industries, 5; Physics, 5; French, German, Spanish or Short Hand, 5; Typewriting or Short Hand, 5; Physical Training Optional, 2; Music, 1.

COMMERCE, GIRLS:—English, 5; Banking, Transportation, Business Organization and Cataloging and Salesmanship, 5; Economics, Commercial Law and Local Industries, 5; Physics or Short Hand, 5; French, German, Spanish or Short Hand, 5; Typewriting or Short Hand, 5; Physical Training Optional, 2; Music, 1.

TECHNICAL, BOYS:—Advanced Mathematics, 5, or Science, 6; American History or Civics, 5; German or Any Academic or Technical, 5; Technical, 15; Physical Training Optional, 2; Music, 1.

TECHNICAL, GIRLS:—American History or Civics, 5; Advanced Science or German, 5; German or Advanced Science, 5; Elective Academic or Technical, 5; Technical, 13; Physical Training Optional, 2; Music, 1.

Discussion

The work of this committee cannot in the nature of things be made exhaustive and it has not been conducted from the standpoint of an experienced educator. It is rather an inspection by engineers of a system of training for men whose future work may be allied to engineering, and for the purpose of placing before the Society, first, a general statement of the status of technical education in Cleveland giving information of interest to the well-informed professional citizen, and second, a statement of the impressions received during such inspection concerning its efficiency and value.

The committee has secured its information from the various printed reports and pamphlets issued by the Board of Education and a personal inspection of the following schools, viz.: The High School of Commerce, the Technical High School, East High School (Manual Training Department), and Case School of Applied Science.

These personal inspections were such as could be made under the guidance of the teachers in a few hours time. At the High School of Commerce, Mr. Weimar, Principal of the school, spent much time in conducting the committee from class to class and in explaining the work. After going about the school and discussing freely its various features, about a dozen of the pupils were collected in one of the class rooms and engaged in conversation concerning their work, the circumstances affecting their choice of a school and their plans for the future.

The total time spent at the school by the committee was six hours.

At the Technical High School, Mr. Barker, the Principal, took the committee in charge and spent two busy hours in making it familiar with the studies and equipment. It should be added that some members of the committee had made previous inspections of the school and were already somewhat informed concerning its work.

At East High School, the committee was welcomed by Principal Lothman and conducted to the Manual Training Department. The work of this school is much less in quantity than that of the others visited, but two hours were spent in the observation and discussion of its work.

At Case School, Dr. Howe, the president, gave up a whole afternoon to the committee and assisted it to secure a good idea of the institution and its work.

With these facilities for observation and study, the committee has arrived at certain conclusions herein stated, but which will now be supplemented by some more extended comments.

Relative to the opening of the High School of Commerce, the Cleveland Chamber of Commerce adopted the following resolution: "That the Cleveland Chamber of Commerce approves

THE HIGH SCHOOL OF COMMERCE

the establishment, in this city, of a business high school; a school which will give a four years' course in studies which pertain directly to business methods and organization; which will teach only those subjects which have a practical application in business; and whose teachers will, as far as possible, be men and women of business experience as well as teaching ability.

"*Resolved*, That the Cleveland Chamber of Commerce heartily endorses the action of the Board of Education in voting to organize a High School of Commerce and promises the Board its hearty support in maintaining it on the lines indicated in the resolution above."

The tabulation of high school studies, included herein, will show how completely these recommendations have been carried out.

That the School is filling a field of its own is shown by the fact that it seems to be drawing its pupils almost entirely from those who would not be attracted to any other high school.

At the opening of the High School of Commerce there were 728 pupils enrolled in the Academic high schools who were taking the commercial course as then given in those schools. Of this number, 535 remained in the Academic High Schools, changing to other courses, only 193 coming to the new school. The opening enrollment was 427, of whom 234 came from the grammar schools. Previous to the opening of the specialized schools, the attendance at the Academic schools had shown no growth. Since that time, notwithstanding the large attendance at the Technical and High School of Commerce, the Academic schools have made a good growth, as shown by the following diagram.

The holding power of the school over its students is shown by the percentages of those entering who remain to complete the course and graduate. That this is in striking contrast to the number who entered the commercial course formerly given in the Academic High Schools and remained for graduation is shown by the following table:

Entered Commercial courses 1900.....	389	
Graduated Commercial courses 1904.....	36	or 9.3%
Entered Commercial courses 1901.....	332	
Graduated Commercial courses 1905.....	45	or 13.5%
Entered Commercial courses 1902.....	373	
Graduated Commercial courses 1906.....	54	or 14.5%
Entered Commercial courses 1903.....	425	
Graduated Commercial courses 1907.....	59	or 14%
Entered Commercial courses 1904.....	426	
Graduated Commercial courses 1908.....	51	or 12%
Entered Commercial courses 1905.....	499	
Graduated Commercial courses 1909.....	78	or 15.6%

While the High School of Commerce has not been in existence long enough to make an exact comparison possible, those graduating are so far a little over 40 per cent of those entering. This estimate is based on the present senior class. Those in the

class expecting to graduate represent 44 per cent of those who entered with them from the grammar schools, and the loss from these will probably be not over 1 or 2 per cent.

The reasons for this increased holding power of a Commerce course in a special school like the High School of Commerce are very many and their analysis would be somewhat complicated. First and foremost is the appreciation on the part of the student of the reason why he is in school. He has a definite end in view, a purpose well within his own comprehension, which not only holds him to the end of his course, but materially improves the quality of his work and the earnestness of his application.

Another factor is the effect on the teacher of the public test of his teaching efficiency. The teachers' work is to be proved out by the business men who employ the graduates. The teacher fully realizes that instruction must be so given that it will last for years and its worth be measured not by the recitation or term examination, but by its permanent retention and the usefulness of the recipient. Efficient teaching is always effective in holding the interest of the pupil.

Again the segregation of those who are studying for business life makes it possible to surround them with an atmosphere conducive to an appreciation of the dignity of their calling. They can be led to appreciate a high standard of business ethics and honesty and to look upon business as a profession far above mere money getting in a way that is impossible where they are grouped with large numbers of those who are attending school with entirely different ends in view and who feel that the highest aims in life are directed in other lines.

The closeness of the relations between the school work and the later work of life is another factor that adds zest to the student's interest.

A lesser motive for application on the part of the pupil is the appreciation of the practical value to the pupil of the teacher's estimate of his character and attainments which are based not on intermittent good work and conduct, but upon the accumulated impression of continuous earnestness of application and of honesty. He knows that this estimate will almost certainly be the principal factor in his recommendation to his future employer.

The co-operative spirit engendered by a large body of students working with their teachers toward a common end is the happy outgrowth of these conditions. The opinion of most of the teaching force of the school is that the spirit of work and good order among the pupils is far above the average and that this spirit is due largely to the causes mentioned.

The growth shown and the holding power manifest in spite of the serious lack of accommodation and equipment is evidence that it supplies a very strong demand within the community.

There is an opportunity in this "Sixth City" for a school which shall set the standard of Commercial Professional spirit, honesty and efficiency for this city and through this city for the nation.

The high minded capable business man, the man of affairs,

is the man of maximum influence in the community. The school that trains this man is the school that shapes, through the man, the civic and commercial ideals of the city and of the state for the next generation. The teaching force, the building, the equipment of the High School of Commerce ought to be commensurate with the value to the community of correct civic and commercial ideals among its business leaders.

In a recent address to the students at the High School of Commerce in celebration of the winning of the silver cup offered by the *Cleveland News* to the school holding the city debating championship for three years, President Ashmun, of the Board of Education, said: "There is no question at all in my mind that you young people have come to a time when all these branches of useful education will be considered the greatest type of education in this country."

While the foregoing is written with especial reference to the High School of Commerce, the comments apply with equal force to conditions in the Technical High School and do not need to be repeated.

The earliest official recognition of manual training or constructive handwork as part of school instruction occurred in 1858 in the primary schools of Finland. In 1872, Sweden reached the

FIRST STEPS IN TECHNICAL EDUCATION

conclusion that such instruction was necessary to counteract the decline of old home industries and concentration in cities. In 1882, France made manual training obligatory in the elementary schools, but lack of sufficient facilities in the workshops delayed its full development. A feature of the French work is the variety of materials and processes used.

In Germany the private-shop apprenticeship with evening and Sunday instruction is favored. Education is compulsory up to the fourteenth year and the great majority of the laboring classes begin work at that age. For the purpose of continuing the instruction of the young workers after they are forced to enter the shops to earn a livelihood, the so-called continuation schools were created. They proved so well adapted to the needs of the workmen that they have been specialized for particular trades and have multiplied throughout the Empire, merging sometimes into trade or technical schools the longer courses of which extending over four years of day school work, turn out thoroughly competent workmen. The dyer who learns his art in the Crefeld laboratories, for example, from his knowledge of the chemistry of colors and the composition of fabrics knows to a penny the cost of dyeing a given number of yards yellow or blue. A like thoroughness characterizes the instruction given in watch-making at Geneva, artificial flower-making in France and Belgium, and wood-carving in Austria. In England apprenticeship is long—seven years in some cases—and there are no schools which take its place. Technical instruction is highly specialized, although they carefully refrain from giving sufficient practice in the shops to enable the

student to acquire dexterity or in any manner do away with the necessity of regular apprenticeship. In fact, in nearly all these English schools only those who are at work in the trade already are permitted to receive the benefits of the instruction.

In the United States education of an industrial character began at the top. The earliest school was the Rensselaer Polytechnic Institute, a school of science and engineering of collegiate grade, established in 1824. The number of such schools increased rapidly after the close of the civil war. No other schools with an industrial tendency except the class above mentioned were in existence prior to 1870. In that year instruction in sewing was made obligatory in every girls' public school in Boston and industrial drawing was introduced into the schools of Massachusetts. Typesetting was offered to the boys and girls of the Jamestown, N. Y., public schools in 1874.

The exhibit of the work in drawing of the Massachusetts schools, the work in metal of the Russian school and in wood of the Swiss school at the Centennial in 1876 drew the attention of educators to the educational possibilities of manual training. The extension of this work has since rapidly developed so that some form of it is now a generally required study in the larger towns and cities of the country. Wherever the experiment was made the training soon became a part of the public school system.

Since 1884, numerous trade schools have been established in the United States. These generally receive the larger part of their income from tuition fees. Some are conducted for the purpose of fostering particular local manufacturing industries, such as the Philadelphia Textile School and the Lowell Textile School. Others provide instruction of a more general application, of which the New York Trade School is a good example. This school provides complete courses in the building trades. There are a few endowed trade schools which make no charge for tuition, like the Williamson Free School of Mechanical Trades, located near Philadelphia, and the California School of Mechanical Arts and the Wilmerding School of Industrial Arts, both at San Francisco.

Trade schools vary considerably in their scope and methods. In the day classes some courses are completed in four months. For evening classes longer time is required. In some trade schools the pupil may choose between a long and a short course in the same trade. The aim in the shorter course is to train the pupil to make a good journeyman; in the other not only to prepare for the trade, but to lay a broader foundation as a preparation for future promotion above the grade of journeyman.

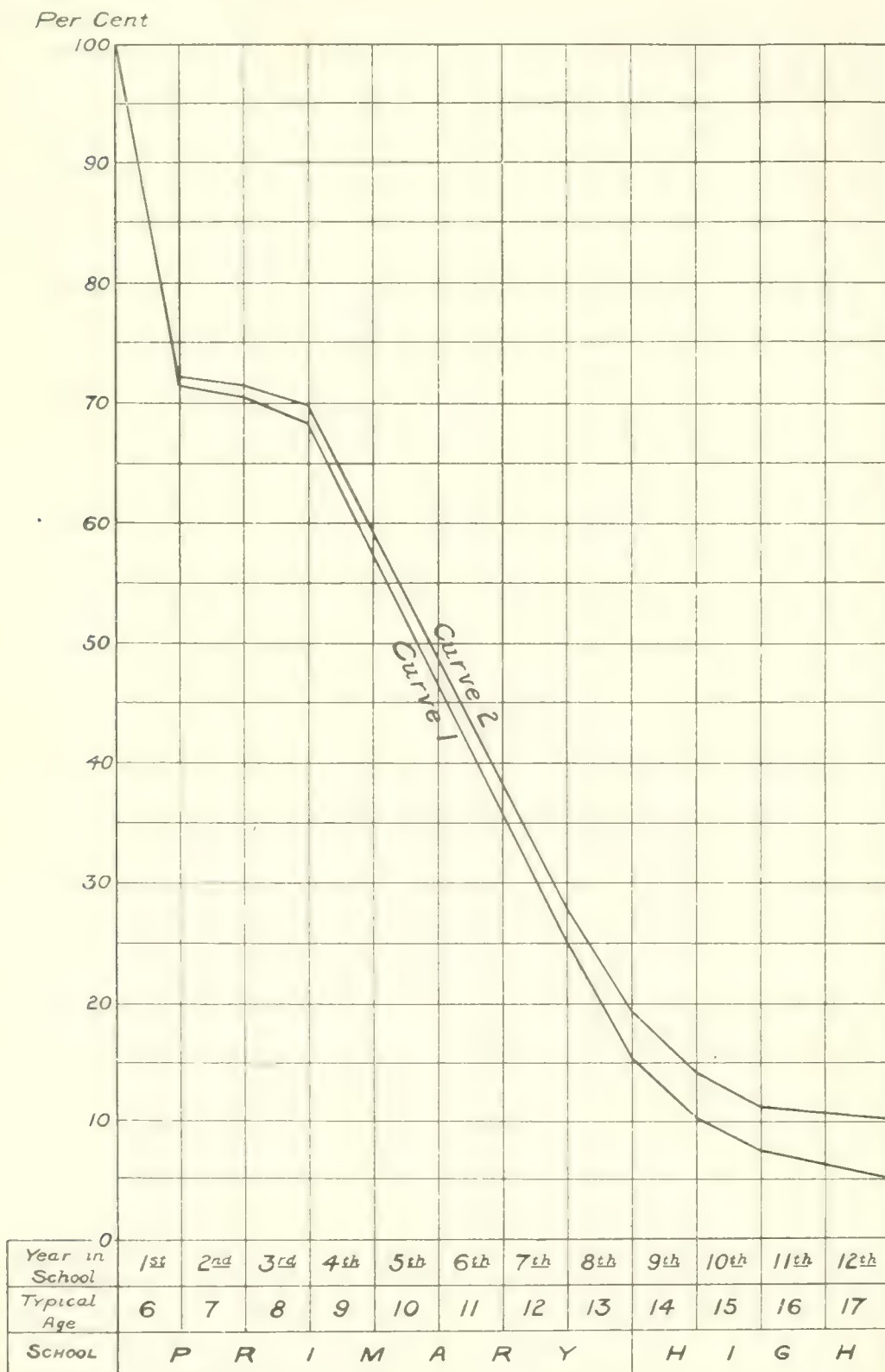
Curve 1 was copied from seventy-third (1909) Annual Report of the Board of Education of Cleveland. Ordinates between Curve 1 and Curve 2 were compiled from recent mortality statistics for the state of Massachusetts.

ATTENDANCE CHART These are the only mortality statistics of American registry showing, in this form, the mortality of young children and are not strictly accurate for any other time or place.

Ordinates above Curve 2 represent the per cent of surviving children out of public school.

Ordinates below Curve 1 represent the per cent of children in school based on whole number entering school the first year.

Ordinates between Curves represent the per cent of loss by death.



The chart indicates that of the children who enter the first grade in the Cleveland public schools more than one-fourth fail to enter the second year, less than one-half enter the sixth grade and but approximately one in twenty graduate from high school. The percentage loss per year is nearly constant from the beginning of the fourth grade to the entrance in high school.

According to Dr. E. L. Thorndike, in sixteen of our largest cities, two out of every three pupils withdraw without more than the work of the seventh grade to their credit.

In the *Saturday Evening Post* of June 1, 1912, Dr. Elliot is quoted as saying that throughout the whole country only one child in nineteen ever enters the high school.

The following table shows the causes and percentage of all withdrawals in both primary and high schools in Cleveland for the year 1908-9.

CAUSE.	PER CENT.
Financial condition of home.....	4.66
Illness in family.....	3.49
Personal illness	14.67
Physical defects	.57
Incapacity	3.57
Indifference	4.26
Failing promotion	.46
Going to work.....	29.33
Left city	38.47
Unknown	.55

For distribution according to age, sex and cause, see page 129, 73d Annual Report of Board of Education (1909).

The percentage of children leaving the city is undoubtedly offset in some degree by children coming into the city during the school age.

VOCATIONAL

GUIDANCE

It is extremely difficult, under present conditions, for the child, the parent or the teacher to decide which of the several courses provided in the public schools is best for any particular child to enter. His vocation in life is usually determined by chance and many are obliged by economic pressure to begin work at the first opportunity offered, even before they have completed the grammar school course. Competition and inexperience make it exceedingly difficult for the child unaided, to find a suitable position at the most critical time of life—when he first seeks employment.

To interest the child and his parents in the study of the child's tastes and possibilities, to decide for what pursuits he is best fitted, to take definite steps towards securing for him the necessary preparation for his work and to advise him in securing a position it is suggested that there be organized a Vocation Bureau. The Executive Committee of this Bureau may be composed of representatives of the public school system, the Chamber

of Commerce, Chamber of Industry, the Engineering Society, the Y. M. C. A., the Y. W. C. A. and other organizations interested in the welfare of the child and the progress of the city. In addition to the Executive Committee, there should be a teacher or a committee of teachers in each elementary and high school and a representative in each of the various social settlement centers.

The functions of the Vocation Bureau should be: To collect information in regard to the opportunities for workers, both those of ordinary ability and of exceptional training, in the various trades and gainful occupations, with special reference to the industries of the city. This will include information concerning the personal and educational qualifications required for admission into different lines of work, information regarding wages of various groups and ages, wages at beginning, whether work is seasonal or throughout the year, hours per day, whether requiring physical strength, close attention or practical skill, description of processes, physical condition of shops and danger from machinery, dust, light, ventilation, drafts, heat, strain, monotony, opportunities for rest, recreation and mid-day lunch, number of new workers taken on per year and time of year admitted, future of industry, whether proficiency in the work leads to promotion into higher grades of the same work or prepares for a better position elsewhere, concerning the tests of efficiency which are set for promotion into higher grades, information regarding the laws relating to the work and labor union restrictions, comments of those engaged in the occupation.

To make such information available through publication, lectures and conferences for the use of teachers, students, parents and of social workers.

To offer advice and direction, in choosing a vocation, to young people and their parents.

To have for record the names, addresses, ages, education, experience, ability and defects of the young who are seeking work. To serve as a means of communication between them and employers and to aid in every proper way the young applicant to find a suitable position.

To encourage continued study in the public schools after the young wage earner has commenced work.

Vocational guidance in connection with the public educational system is of recent development in this country, but it has roused strong and widespread interest.

The organizers of the movement believe that proper guidance at the critical period of adolescence will enable beginners to find themselves early and to make good in the work they are doing, and will, moreover, stimulate them to prepare for advancement and thereby benefit themselves, their employers and the community.

For detailed information on this subject the reader is referred to the 25th Annual Report of the Commissioner of Labor, Washington.

following social betterment societies, and to them we desire to call the attention of the public:

Lend-a-Hand Mission, Alta Social Settlement, Central Friendly Inn, Hiram House, Associated Charities, Y. M. C. A., Y. W. C. A. Letters from these various societies describing the work in which they are engaged have been received by the Committee and are on file with this Society.

CONCLUSIONS

The schools of Cleveland now afford the mental and industrial training necessary for a first-class education in engineering.

There is a continuity of instruction from the earlier classes in the technical schools to graduation at Case School of Applied Science, which permits the accumulation of the greatest possible familiarity with subjects of an engineering nature.

Manual training as a cultural study for the grades and academic high schools needs further development.

The training afforded by the Technical High School for pupils who wish to engage in work of an industrial nature, is unexcelled. For those who wish to continue their studies and engage in professional work, it gives a college preparatory course. Those graduates who enter colleges where shop work is required, do so with advance standing because of their training in the school.

The training afforded by the High School of Commerce is admirably adapted to the future needs of the pupils both in private life and in commercial occupations. The graduates have opportunities for higher education in a limited number of colleges.

The courses of study in these schools afford excellent discipline and develop a spirit of co-operation vitally essential in all collective efforts of mankind.

The pupils are actively interested in their studies and in their schools. They have generally selected their schools for certain definite purposes and attend with the full belief that they are deriving some material benefit from their study.

Large numbers of children who otherwise would not attend school are attracted and have their interest maintained because of the immediate practical value of the training afforded by these schools.

The training afforded by the technical and commerce schools, and the practical knowledge acquired therein are of great value to the ordinary citizen in his everyday life. They must be acquired in some degree by a large majority of the men who rise above the level of mediocrity.

The public school system of a great city should afford both elasticity and variety in the work of the children. To prescribe a single line of development for all children in a city where the habits and conditions of life are as diverse as those of Cleveland is to throttle the lives of a majority of the children, to bar their progress in upward development and to foster the ills that are

the companions of ignorance and discontent. The establishment of technical schools with opportunities for continuous study throughout the year, tends toward such elasticity and variety.

Frequent changes of policy in matters affecting the courses of study and order of promotion are demoralizing to both the pupils and the instructing staff and are incompatible with the highest efficiency in education.

The best results in educational work will be secured when the character and reputation of those in charge of the work are such as to command the admiration of the pupils and develop among them a worthy spirit of emulation. Any form of dissension or controversy in the school organization is harmful to the children and should be eliminated. Adverse criticism of the school organization, unless well founded and followed quickly with a remedy, becomes in time a confession of impotence on the part of the critics.

The greatest present need of the schools is a concentration of authority in a single executive head of sufficient strength and breadth of experience to weld the several elements of Cleveland's educational system into one harmonious and responsive whole.

The buildings and equipment of the High Schools of Commerce are wholly inadequate. A new building, designed to meet the especial needs of the students in these schools, is urgently needed and it should be liberally equipped with all the modern apparatus necessary to facilitate the instruction.

Instruction should be provided during the summer months for all regularly enrolled students who wish to attend school during that time.

The efficiency of the educational system of the city is less than 50 per cent. A line showing the average attendance from the time of entering the first grade until graduation from High School falls below a straight line connecting those points. Of the children entering the first grade of our schools the percentage of those who die during school years is the same as the percentage who graduate from High School.

A Vocation Bureau should be organized to assist both parents and children in selecting for the children the occupations most favorable under existing conditions, and to adapt the children's education to the needs of the chosen occupations.

The Society should lend its support to the development of technical education. Such support may consist in furnishing speakers on suitable occasions for the discussion of subjects pertaining to education and engineering; in rendering aid to worthy students at Case School and in providing some direct transition for students of engineering, from their studies at Case School to membership in the Society.

Individually, the members of the Society can do much to further the work of the schools by assisting the graduates to find the kind of employment for which they have been prepared.

In this day, when much is said of conservation and efficiency, it is startling that so little is being said of the greatest

waste of all, the waste of human energy through lack of training and misdirected effort. The wealth which is available in any community through the wise training of the children, exceeds all that can be attained in any other manner.

ALBERT J. HIMES, *Chairman*.

JAS. F. BARKER.

CHAS. F. DUTTON.

MONROE WARNER.

LIST OF PUBLICATIONS USED IN THIS REPORT AND ON FILE
IN THE SOCIETY'S LIBRARY

Seventy-third Annual Report of the Board of Education of Cleveland (1909).

Seventy-fourth Annual Report of the Board of Education of Cleveland (1909-10).

The Technical High School, Cleveland. Outline of course of study and description of equipment (1910).

The High School of Commerce (Cleveland).

Report of Elementary Industrial School, Cleveland (1910).

Case School of Applied Science Catalog for 1911-12.

School Laws of the State of Ohio (1910).

Twenty-fifth Annual Report of the Commissioner of Labor.

Third Annual Report of the Commission on Industrial Education, January, 1909 (Massachusetts).

Report of the School Board of the City of Springfield, Massachusetts (1910).

Eighty-first Annual Report of the Public Schools of Cincinnati, Ohio (1910).

Nineteenth Annual Report, Lend-a-Hand Mission.

See Twenty-fifth Annual Report, Commissioners of Labor, 1910, for Account of Apprentice Schools, New York Central Lines.

LIBRARY

There have been expended for Library purposes during the year the following amounts:

Books	\$ 64.24
Periodicals	46.45
Binding	113.30
Equipment	119.00
	\$342.99

An arrangement has been perfected whereby a large number of duplicate periodicals have been sold or exchanged, and it is expected that the remaining stock will be disposed of in a similar manner. This entire stock has been cataloged and listed with dealers.

Work upon the cataloging of the Library is now well under way and it is hoped that a catalog may be issued sometime during the coming year. Classified lists covering the various branches of engineering should be published from time to time.

During the year the following books have been added:

BY GIFT:—

American Institute of Electrical Engineers (Transactions), Vols. 10-29.
 American Railroad Journal, Vols. 2-4.
 Cement, Vols. 1-6, 9-10.
 Cement Age, Vols. 1-11.
 Electric Railway Journal, Vols. 32-38.
 Flood Commission Report, Pittsburgh, 1911.
 Plums of New York, Hedrick.
 Railway Age Gazette, Vols. 29-51.
 Street Railway Journal, Vols. 20-31.

BY PURCHASE:—

Air Brake, by Wood.
 American Machinist Gear Book, by Logue.
 Canal Record, Vol. 1.
 Cassier's Magazine, Vols. 34-39.
 Compressed Air and Its Applications, by Hiscox.
 Corrosion and Preservation of Iron and Steel, by Cushman & Gardner.
 Cost Keeping, by Bunnell.
 Drop Forging, Die Sinking and Machine Forming of Steel, by Woodworth.
 Electric Crane Construction, by Hill.
 Electric Power Plant Engineering, by Weingreen.
 Factory Organization and Administration, by Diemer.
 Facts, Figures and Formulae for Irrigation Engineers, by Buckley.
 Gas Turbine, by Suplee.
 Hydro-Electric Practice, by Von Shon.
 Influence Lines for Bridges and Roofs, by Burr & Falk.
 Law of Contracts, by Wait.
 London Engineering, Vols. 35-61.
 Metallurgy of Iron & Steel, by Stoughton.

Principles of Reinforced Concrete Construction, by
Turneure & Maurer.
Western Railway Club, Vols. 11-20.

Also, there have been sent for distribution among the members, 40 copies of the Ohio Topographic Survey for 1910, which may be procured at the rooms upon application.

The number of periodicals and transactions received has been increased materially and includes several valuable foreign publications. The complete list follows:

Aeronautics.
American Architect.
American Carpenter & Builder.
American City.
American Engineer.
American Electric Railway Association, Proc.
American Institute of Electrical Engineers, Proc.
American Iron and Steel Association, Bulletin.
American Machinist.
American Society of Civil Engineers, Trans.
American Society of Engineering Contractors, Jour.
American Society for Testing Materials, Proc.
Annals of The American Academy of Political
and Social Science.
American Society of Mechanical Engineers, Jour.
Architectural Review.
Association of Engineering Societies, Jour.
Automobile.
Barge Canal Bulletin.
Board of Trade and Engineering Journal.
Boston Society of Civil Engineers, Bulletin.
Brooklyn Engineers' Club, Proc.
Bureau of the Census, Bulletins.
Bureau of Mines, Bulletins.
Bureau of Standards, Bulletins.
Canadian Engineer.
Canadian Society of Civil Engineers, Trans.
Canal Bulletin Record.
Cassier's Magazine.
Castings.
Cement Age.
Cement and Engineering News.
Central States Water Works Association, Proc.
Century.
Coal Age.
Colorado Scientific Society, Proc.
Columbia University.
Concrete.
Concrete Institute, Trans.
Connecticut Society of Civil Engineers, Proc.
Cornell Civil Engineer.
Cosmopolitan.
Department of Agriculture, Bulletin.
Electric Journal.
Electric Railway Journal.
Electric Traction Weekly.
Electrical Review and Western Electrician.
Electrical World (Monthly and Weekly).
Engineering (London).
Engineering-Contracting.
Engineering Magazine.
Engineering and Mining Journal.
Engineering News.
Engineering Record.
Engineering Society of Wisconsin, Proc.

Engineers' Club of Baltimore.
 Engineers' Club of Philadelphia, Proc.
 Engineers' List.
 Engineers' Society of Pennsylvania, Jour.
 Engineers' Society of Western Pennsylvania, Proc.
 Factory.
 Foundry.
 Franklin Institute, Jour.
 Harper's Magazine.
 Harpers' Weekly.
 Heating and Ventilating Magazine.
 Ice and Refrigeration.
 Ideal Power.
 Illuminating Engineer.
 Indiana Sanitary and Water Supply Association.
 Industrial World.
 International Association for Testing Materials,
 Proc.
 Industrial Engineering and The Engineering Digest.
 Interstate Commerce Commission, Bulletins on R.
 R. Expenses.
 Iowa Engineering Society, Proc.
 Iowa State College Engineering Experiment Sta-
 tion, Bulletins.
 Iron Age.
 Iron Trade Review.
 Le Ciment.
 Locomotive.
 McClure's Magazine.
 Manitoba Engineer.
 Metal Industry.
 Metallurgical and Chemical Engineering.
 Michigan Technic.
 Mill Supplies.
 Mine and Quarry.
 Mines and Minerals.
 Mining and Engineering World.
 Mining and Scientific Press.
 Motor Age.
 Municipal Journal and Engineer.
 Munsey.
 National Builder.
 National Electric Light Association, Bulletins.
 National Geographic Magazine.
 Nebraska Blue-Print.
 Nova Scotia Institute of Science, Proc. and Trans.
 Ohio Architect, Engineer and Builder.
 Ohio Society of Mech., Elec. and Steam Engineers.
 Jour.
 Ohio State Board of Health, Bulletin.
 Park and Cemetery and Landscape Gardening.
 Power.
 Professional Memoirs.
 Railway Age Gazette.
 Railway and Engineering Review.
 Railway Engineering and Maintenance of Way.
 Railway Master Mechanic.
 Refrigeration and Electricity.
 Rock Products.
 Science Conspectus.
 Scribner's Magazine.
 Sibley Journal of Engineering.
 Southern Electrician.
 Southern Engineer.
 System.
 Technologist.

University of Illinois, Bulletins.
University of Toronto (Applied Science).
University of Wisconsin, Bulletin.
Water and Gas Review.
Western Engineering.
Western Railway Club.
Western Society of Engineers, Jour.
Woodcraft.

From the above list and donations of miscellaneous periodicals received from the members, 119 volumes have been bound and placed on the shelves.

During the coming year provision should be made for shelving the current periodicals; work on the catalog and card index should proceed; efforts to secure foreign exchanges should be continued; a larger sum should be expended for late books, and the collection of topographical sheets should be increased.

GEO. H. TINKER,
Librarian.

PROGRAM COMMITTEE

Shortly after the appointment of the Program Committee by President Roberts, the members were called together and organized. As nothing in the way of assets was left to this committee by its predecessor, it seemed impossible to get a satisfactory program for the first meeting. Upon the suggestion of one of our members it was decided to make this an inspection trip to the National Tube Co.'s plant at Lorain, O. This was accomplished with gratifying results.

At the subsequent meeting of the Program Committee a schedule of programs for the entire season was drawn up, having in view the different classes of our membership, so that all would be treated fairly. The subjects in each class were definitely decided upon, and those whom it was desired to present them selected. In addition to this arrangement, the chairman of each of the sub-committees of the Society was to select one program relative to such committee work, and also the speaker of the occasion.

After the complete schedule was arranged, it remained for the Program Committee to get in touch with the speakers desired and with a single exception, each and everyone responded.

The Program Committee has taken upon itself, subject to the approval of the incoming Program Committee, the program for the first two meetings of next year. This was done in order to avoid, if possible, the same trouble that was experienced by the present Program Committee. The Program Committee feels that its success, if any, in furnishing the programs for the year is largely due to the schedule prepared and the systematic effort to have all the programs arranged for as early in the year as possible, and provide one or two spares in case of the failure of any speaker to appear at the appointed time. This gives the speaker ample time to prepare his paper and relieves the Program Committee of that eleventh hour effort, which is not conducive to good results.

There is another form that has been carried out, which may or many not have been formerly used in this Society, namely, a formal letter of thanks from the Program Committee has been sent to each speaker presenting a program shortly after the same was presented. This is in addition to the formal vote of thanks taken at each meeting.

There is also one thing more that the incoming Program Committee might use to advantage, namely, frequent inspection trips to plants in and around Cleveland. This need entail very little expense, if any, and it appeals to a large number of our members. It should be in addition to the regular program and it might be well for the incoming Program Committee to plan one of these for each month and to consider them when they are

planning their other schedule, so arrangements can be satisfactorily made.

The Program Committee feels under obligations to many of the members of the Society, who have made valuable suggestions relative to the nature of the programs, and it is the hope of the present Program Committee that this same courtesy may be extended to its successor.

Respectfully submitted,

JAMES H. HERRON,
Chairman.

MEMBERSHIP COMMITTEE

MR. PRESIDENT:—

During the past year the Membership Committee has endeavored to increase the membership of the Society by adding to the list men of engineering ability, and also by adding to the records the names of men who are eligible and should belong to the Society, but are not yet ready to join us.

This list of prospective members is on file in the secretary's office and shows clearly those of the number whom the members of this committee have called upon and given a personal invitation to come and be identified with us. Their reason for not accepting, or when they will accept, or whether or not they should be seen again, and at what time is all given on the record.

Thus you can see that this record will benefit the new committee next year and save considerable work and time and enable them to look after new men, or men who this committee did not see this year.

This record contains the names of 775 men, most all of whom are eligible to membership in this Society; 340 of these names were obtained the past year—the remainder being obtained from a list from previous years.

We wish to urge every member of the Society to place in the hands of the committee or the secretary names of men whom they know are eligible so that they may be placed on this record, given an invitation to join us and "followed up" by the Membership Committee.

The records above referred to are in card system form and are the result of recommendations made by the Membership Committee report last year and this committee wishes to urge their use and continuance to the next Membership Committee.

*One year ago, there were 458 members on the roll in good standing. During the past year, 104 new names have been added and 13 names withdrawn, which leaves 549 as the membership of the Society at this time.

Respectfully,
E. S. CARMAN,
Chairman.

*A correction for members elected at the June meeting and for resignations is necessary to make these figures agree with those of the Secretary, on page 22.

AUDIT REPORT
THE CLEVELAND ENGINEERING SOCIETY, CLEVELAND
JUNE 1, 1912

REPORT FROM ERNST & ERNST, CERTIFIED PUBLIC ACCOUNTANTS.

June 10, 1912.

EXECUTIVE BOARD, THE CLEVELAND ENGINEERING SOCIETY,
CLEVELAND.

GENTLEMEN :—

Pursuant to request, we have audited the books of account and record of The Cleveland Engineering Society, Cleveland, for the year ended May 31, 1912, and submit herewith our report.

We verified cash on deposit at May 31, 1912, by officially signed statements from the depository banks. All recorded cash receipts for the period were traced by us into the bank deposits, with the exception of item of \$75.00, shown by the records as paid out of cash received by Mr. Black for dinners of members at Lorain. We found all recorded disbursements through the bank were supported by officially signed and properly endorsed checks on file and, with the exception of vouchers covering petty cash disbursements, these were further supported by invoices, receipts and other proper data.

We found only a small proportion of the petty cash disbursements, aggregating \$609.22 for the year, were properly supported by signed receipts on file, and we recommend that receipts be obtained for all cash disbursements covering postage and miscellaneous expenses.

The book value of permanent accounts aggregated \$5,643.59 at May 31, 1912, and is without appraisal by us.

Unpaid members' accounts were proved by trial balance of the individual member's accounts. We direct attention to members' delinquent accounts, aggregating \$24.50, which, in our opinion, should be charged off.

In accounts payable of \$413.52 provision has been made for all known liabilities for unpaid purchases, salaries, etc., submitted to us.

We have also made provision in the preparation of our balance sheet for balance of \$1,063.55, due The Caxton Building Company, in settlement of amount due on unexpired lease.

We were informed that this account may be finally settled for somewhat less than the above amount, but as no definite arrangement has as yet been made, we are providing for the full liability at the date named.

Following is a condensed summary of the surplus account for the year :

BALANCE, June 1, 1911—Per Ledger..

\$11,094.28

ADJUSTMENTS.

Dues charged members June 1, 1911, for
year ended May 31, 1912, considered
as income in closing books as of
May 31, 1911..... \$4,948.00

Less:—Reserves provided for antici-
pated discounts on above dues.... 838.00

\$4,110.00

Prepaid advertising space at June 1,
1911, considered as previous year's
earning 195.75

Commission on May, 1911, advertising
collections, applicable to year ended
May 31, 1911..... 20.31

\$4,326.06

Less:—Adjustment of sale of one So-
ciety pin May, 1911, not entered
on books, and error of one pin in
inventory, taken May 31, 1911..... 4.50

4,321.56

Adjusted surplus May 31, 1911

\$6,772.72

ADDITIONS.

Net profit for year ended May 31, 1912,
per income and expense exhibit... \$ 850.57

Reduction in H. J. Bradshaw invoice.... 1.79 \$ 852.36

DEDUCTIONS.

Accounts of members charged off less
recoveries on accounts previously
charged off \$ 54.25

Caxton Building Rent Adjustment (esti-
mated) 1,063.55 1,117.80

Net deduction for year.....

265.44

Balance May 31, 1912.....

\$6,507.28

We hereby certify that we have audited the books of account and record of The Cleveland Engineering Society, Cleveland, as herein outlined, and that, in our opinion, based upon the records submitted and information furnished, the annexed balance sheet is properly drawn up so as to correctly set forth the financial condition of the Society at the date named and the relative operating statements are correct.

Very truly yours,

[SEAL]

ERNST & ERNST,

Certified Public Accountants.

BALANCE SHEET

THE CLEVELAND ENGINEERING SOCIETY, CLEVELAND
JUNE 1, 1912

ASSETS

PERMANENT.

Furniture and fixtures	\$1 764.05	
Library equipment	701.75	
Books	3,064.49	
Bound periodicals (cost of binding only)	113.30	\$5,643.59

CURRENT

CASH.

On deposit	\$2,268.28	
On hand	20.00	\$2,288.28

BILLS RECEIVABLE.

G. S. Hanford note.....	22.00	
-------------------------	-------	--

ACCOUNTS RECEIVABLE.

Per exhibit	\$ 272.29	
Delinquent members	24.50	296.79

INVENTORY.

18.39	2,625.46
	\$8,269.05

LIABILITIES

CURRENT

ACCOUNTS PAYABLE.

For purchases	\$ 288.52	
Unpaid salaries	125.00	
The Caxton Building Company.....	1,063.55	\$1,477.07

ADVANCE PAYMENTS.

Dues	\$ 2.50	
Entrance fees	65.00	
Advertising	212.75	280.25

OUTSTANDING COUPONS.

\$ 4.45	\$1,761.77
	6,507.28

NOMINAL

SURPLUS.

\$8,269.05

INCOME AND EXPENSES

THE CLEVELAND ENGINEERING SOCIETY, CLEVELAND FOR THE YEAR ENDED MAY 31, 1912

INCOME

MEMBERS' DUES.

	DUES ASSESSED.	DISCOUNT TAKEN.	NET.
Active	\$4,768.50	\$ 634.00	\$ 4,134.50
Associate	465.00	64.00	401.00
Corresponding	220.50	32.75	187.75
	\$5,454.00	\$ 730.75	\$ 4,723.25

ENTRANCE FEES.

Eighty-nine members balloted on during year	445.00
--	--------

ADVERTISING.

For space in JOURNAL.....	1,389.36
Total income	\$ 6,557.61

EXPENSES

Salaries	\$1,467.33	
Cost of JOURNAL and other stationery...	1,514.05	
Postage	440.74	
Telephone and telegraph.....	49.53	
Repairs and maintenance.....	65.60	
Office expense	110.33	
Rent	1,291.74	
Periodicals (technical)	29.45	
Periodicals (sundry)	17.00	
Entertainment—Extraordinary	69.14	
Taxes and insurance.....	24.80	
Electric light	97.12	
Commissions on advertising.....	341.87	
General expense	326.55	
Special entertainments, lectures, etc.....	\$ 489.25	
Less:—Tickets sold	452.00	37.25
		5,882.50
Net income		\$ 675.11

OTHER INCOME

CIGARS.

Sales	\$	75.05		
Cost of sales:				
Inventory, June 1, 1911.....	\$	22.50		
Purchases		52.01		
	\$	74.51		
Less:—Inventory, June 1, '12		18.39	56.12	
Net profit			\$	18.93

POOL AND BILLIARDS.

Sales	\$	42.75		
Less:—Repairs and supplies.		16.25		
Net profit				26.50

SOCIETY EMBLEMS.

Sales—19 at \$2.50.....	\$	47.50		
Cost of sales:				
Inventory, June 1, 1911.....	\$	8.00		
Purchases		30.00	38.00	
Net profit				9.50

MISCELLANEOUS.

Interest on deposits.....	\$	80.84		
Sales of old JOURNALS, books, etc.		39.69	120.53	175.46
Net addition to surplus for period				\$ 850.57

SURPLUS

THE CLEVELAND ENGINEERING SOCIETY, CLEVELAND MAY 31, 1912

<i>BALANCE</i> June 1, 1911—Per Ledger...		\$11,094.28	
<i>LESS—ADJUSTMENTS.</i>			
Dues charged members June 1, 1911, for year ended May 31, 1912, con- sidered as income in closing books as of May 31, 1911.....	\$4,948.00		
Less:—Reserves provided for anticipated discounts on above dues.....	838.00		
		\$4,110.00	
Prepaid advertising space at June 1, 1911, considered as previous year's earn- ings	195.75		
Commission on May, 1911, advertising collections, applicable to the year ended May 31, 1911.....	20.31		
		\$4,326.06	
Less:—Adjustment of sale of one Society pin, May, 1911, not entered on books, and error of one pin in inventory taken May 31, 1911.....	4.50	4,321.56	
Adjusted surplus May 31, '11			\$ 6,772.72
<i>ADDITIONS FOR YEAR.</i>			
Net profit for year ended May 31, 1912, per income and expense exhibit...	\$ 850.57		
Reduction as of August 31, 1911, of H. J. Bradshaw invoice for commission due	1.79	\$ 852.36	
<i>LESS—DEDUCTIONS.</i>			
Dues of members charged off during year due to resignations, etc.....	\$ 93.00		
Less:—Recovered during year on ac- counts previously charged off.....	38.75		
		\$ 54.25	
Providing for liability on Caxton Build- ing rent adjustment deduction.....	1,063.55	1,117.80	
Net deduction for year.....			\$ 265.44
Balance, May 31, 1912.....			\$ 6,507.28

BANK RECONCILEMENT

THE CLEVELAND ENGINEERING SOCIETY, CLEVELAND
MAY 31, 1912

COMMERCIAL ACCOUNT

THE CENTRAL NATIONAL BANK.

5-31-12—*BALANCE* on deposit, per
signed statement from bank..... \$ 330.31

LESS—CHECKS OUTSTANDING.

NO.	PAYEE.	AMOUNT.		
1181	Chamber of Commerce Club.....	\$ 32.00		
1190	A. M. Scotland.....	10.00		
1191	Skeel Bros. Co.....	17.00		
1192	Fred Wilkins.....	6.52	65.52	
	Balance per books.....			\$ 270.79

LIBRARY FUND

THE SUPERIOR SAVINGS & TRUST CO.

5-31-12— <i>BALANCE</i> on deposit, per signed statement from bank.....	\$1,040.70		
Checks outstanding			
5-31-12— <i>BALANCE</i> , per books.....	\$1,000.30		
Add:—Interest on deposits not on books:			
July 1, 1911.....	\$ 20.00		
Jan. 1, 1912.....	20.40	40.40	1,040.70

PERMANENT FUND

THE SOCIETY FOR SAVINGS.

5-31-12— <i>BALANCE</i> on deposit, per signed statement from bank.....	\$ 956.79		
Checks outstanding			
5-31-12— <i>BALANCE</i> per books.....	\$ 916.35		
Add:—Dividends on deposits:			
July 1, 1911.....	\$ 16.09		
Jan. 1, 1912.....	24.35	40.44	956.79
Total cash on deposit.....			\$ 2,268.28

JOURNAL

OF

The Cleveland Engineering Society

Published Bi-Monthly
by the Society

September, 1912

Chamber of Commerce Bldg.
Cleveland, Ohio

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River and Harbor Improvements from an Engineering Standpoint

JOHN MILLIS, COLONEL, CORPS OF ENGINEERS, U. S. ARMY.

The above title conforms to that in common use to designate a considerable variety of engineering work that has been undertaken in the United States and in the outlying possessions, having as a general object the betterment of the conditions of nature that directly affect navigable waters. Obviously among the first needs of navigation would be found, for ocean-going vessels and those engaged in lake traffic, properly located and well sheltered harbors of sufficient area and depth, and for inland navigation, river channels free from obstructions and of proper dimensions. These requirements were, in fact, what led to the earliest artificial works for bettering navigation conditions and this suggests the origin of the general term, *River and Harbor Improvements*, which we still use. It is scarcely necessary to say that works so indicated now include many undertakings that would not be suggested by this general designation, particularly those relating to purely artificial channels and canals. A convenient division of the subject, however, especially for consideration of engineering features, is into the two general classes of works indicated by the title; those connected with improvements of harbors proper, and those relating to navigable channels in general. The present official form of title of the regular appropriation act making provision for these works as adopted by Congress is as follows: *An Act Making Appropriation for the Construction, Repair and Preservation of Certain Public Works on Rivers and Harbors, and for Other Purposes*. This is commonly known as the River and Harbor Act.

In this country a very large portion of all these works have been carried out by the Federal Government, principally through the agency of the Engineer Department. Many works of importance for the improvement of navigation are, however, in charge of State and municipal authorities and still others are being done by corporate and private interests, but as questions of administration do not have any very direct bearing on engineering features no special distinction in respect to administration will be recognized in this paper.

In the United States at the present date there are many momentous problems relating to the development and utilization of the abundant resources of our country that are of great interest to the hydraulic engineer. These are related to irrigation and reclamation of the great arid areas of the west, the drainage and utilization of the extensive swamp regions in various localities, particularly in the south, the regulation and maintenance of the levels of our great lakes, the control of the floods in our extensive river systems, and the development and utilization of power from the moving waters, as well as the improvement of the natural

conditions so as to make use of water for transportation purposes. Mention must also be made of questions of water purification, of drainage, and of sewage treatment and disposal, all of which have a direct bearing on the general subject of sanitation and the public health. Obviously these various subjects are inter related, often intimately, and one result of the more advanced thought of engineers as well as of statesmen on the subject is a recognition of these relations and of the importance of taking full advantage of all opportunities to derive the fullest benefits for human needs practicable from works undertaken in connection with any of the above objects, as well as of avoiding unnecessary detrimental effects upon the availability of water for one need or purpose when undertaking works to utilize it for another.

From so extensive a field it is necessary to select something concrete for specific consideration in order to justify occupying the time and attention of the Society for even a brief period. To attempt anything like a complete or detailed discussion of the subject which the title covers would result in a lengthy paper made up principally of extracts and quotations from available published reports and descriptions, and this would be neither useful nor entertaining upon an occasion like the present, even if it were at all practicable. Only a general view of certain classes of works of special interest will therefore be given, with some ideas and suggestions that engineers not directly engaged in this line of work may not be familiar with, but which may be of professional interest.

One division of our general subject which is of special and wide-spread interest at this particular time is suggested by the recent disastrous flood in the lower Mississippi Valley, which but for the fact that it has been overshadowed by another recent calamity of more exceptional character, the wreck of the "Titanic", would be recognized by the general public as the most serious misfortune of its kind that has yet occurred in this country. It concerns a portion of the river that has been under improvement to better conditions of navigation and of flood control for many years and on which a large amount of money has been expended. Another division which will be considered, at least briefly and in a general way, is the question of the diminishing levels of the Great Lakes; a matter that is of special interest and importance to us locally as affecting Lake Erie harbors and one which also has a somewhat indirect relation to the Mississippi problem.

The present unprecedented situation along the Mississippi attracts special attention to the problem of controlling the river during extreme high stages and emphasizes the fact that this phase of the question now far outweighs in importance, from the human standpoint, all considerations of navigation alone on that great stream.

Reference to a map of North America, on which are indicated the drainage areas tributary to the Great Lakes and to the Mississippi systems respectively, will show what a very large portion of the surface area of the United States and Canada these comprise, but when consideration is given to the population and productive resources of these combined areas as compared to the regions

outside of it, the importance of these two basins is still more evident. The land area of the Great Lakes basin is, however, relatively small compared to that of the Mississippi basin, since in the former the lakes occupy a large percentage of the surface.

Another map shows the relative importance of the various rivers and channels in the United States as highways of commerce, and from this it appears that the waterway of the Great Lakes is far in the lead of any other waterway in the country in the annual tonnage of the water-borne traffic and that the commerce of the Mississippi is at the present time relatively small. In addition to navigation interests proper we find in the lower Mississippi Valley a vast agricultural region of great fertility and a large population, though its possibilities have as yet been only partially developed. Immense sums have been expended by the National Government and the local interests in works, the most extensive of their kind in the world, to control the floods of the river and to promote commerce and navigation. The present situation may well appear to many unacquainted with the conditions as at least discouraging, and it has, as in times past, called forth criticism and suggested remedies from persons entirely unacquainted with the conditions or the magnitude of the problem. As a whole, this river system presents for the engineer the most formidable problem of its kind that exists in this country or that is likely to be undertaken anywhere in the world, and it will be of interest at this time to briefly review some of the main features of the river and its principal tributaries and the works of improvement that have been undertaken and are now being carried out.

The extreme upper Mississippi presents the only example in the United States of works for regulating a stream for navigation purposes by the *reservoir system* and this is one of the largest of its kind in the world. Five reservoirs have been established, mostly by building dams with regulation gates across the outlets of several natural lakes at the headwaters, 350 to 400 miles above St. Paul, and these are operated so as to store water during the flood period and to discharge it during the season of low water and thus improve navigable depths in the river below. The reservoirs have a total area of 480 square miles. The system is only partially successful. It is estimated that the average increase of depth in the river is about a foot at St. Paul, gradually diminishing down stream as the river gets wider, and that no effect is produced below the head of Lake Pepin, which is an expansion of the river 50 miles below St. Paul.

From St. Paul to St. Louis the river flows in a narrow valley from one to five miles wide, sharply defined by high and nearly continuous bluffs on both sides, and the only areas subject to overflow are the bottom lands in this valley. There are levees or embankments at various places for local protection against overflow, but no general or continuous levee system. The slope and current throughout this part of the river, a length of some 600 miles, are in general moderate, and extensive works for improving the low water depths for navigation purposes have been in progress for some years and are still going on. These improvements are of the "open channel" type and consist mostly of low training

dikes and partial dams built of timber, brush and loose stone, and designed to render the low water channel generally regular in width and to secure an approach to uniformity in slope and depth with sufficient depth for shallow draft river boats without material disturbance of the conditions at high stages of the river. A channel depth of about $4\frac{1}{2}$ to 5 feet is maintained over this part of the river during the season of navigation. At Keokuk, Iowa, a side channel with lock was built a number of years ago by the general government to enable boats to pass the rapids, but these works are being replaced by an extensive water power development project which includes a dam extending across the river with locks to accommodate navigation.

Just above St. Louis, the Missouri comes in and the addition of this important tributary, whose waters are heavily laden with silt or sediment, produces a marked change in the characteristics of the Mississippi. From St. Louis to the mouth of the Ohio at Cairo, 150 miles, the slope of the river is greater than just below. The immediate valley has a very uniform width of about five to six miles, sharply defined as above by bluffs and high ground, and the effects of overflow are correspondingly limited. Extensive improvement works in the form of permeable dikes have been built along this portion, designed to restrict the width of the river at low water, to improve the depth of same, and to induce permanency of the immediate banks by deposit of sediment over the dikes. The low water navigable depth between St. Louis and Cairo is about 8 feet. The construction of dams at two different points in this part of the river for the development of water power has been under consideration.

The Ohio is the most important navigable stream in a commercial sense of the Mississippi system. The business done on it is largely the transportation of coal down stream from the soft coal regions tributary to its headwaters. The Ohio is also one of the most important factors in the flood conditions of the lower Mississippi. Its improvement for navigation by constructing locks and movable dams so as to divide the upper reaches into pools or sections of slack water at low stages, while preserving essentially natural conditions at high stages by lowering the dams, has been in progress for many years, and this is the most extensive example of this form of river improvement that has been undertaken in America. The present aim is to secure a minimum navigable depth of 9 feet and the total expenditure involved is estimated at about \$60,000,000. Boats pass the rapids and falls in the Ohio at Louisville, Ky., by a side canal with locks. The immediate valley of the Ohio, like that of the upper Mississippi, is of limited width and is defined by high banks or bluffs, so the effects of high water, though frequently serious locally as at Cincinnati, Pittsburgh and other cities on the river, are limited in the extent of the area involved.

From Cairo to the Gulf of Mexico, a distance of about 1,050 miles, the Mississippi has characteristics markedly different from those that prevail above. At Cairo, or a short distance above, begins what is termed the lower "alluvial valley" of the river, a broad flood plain formed entirely in recent geological times from

material which was presumably all brought down by the river waters, and of such low elevation that under natural conditions it was all subject to overflow during high stages of the Mississippi. The flood plain or valley is sharply defined on the east by a line of high earth bluffs composed of material of an older geological formation. It is limited in a similar manner on the west, but the bluffs are generally lower in relief and have a much more irregular outline than on the east. On the south the alluvial valley runs out into the Gulf of Mexico, where it is still being extended by the deposit of the silt of the river water. While the surface of the alluvial valley is generally flat and level, it presents a variety of surface features in the way of ponds, lakes, rivers, streams and bayous, and besides the areas under cultivation there are large portions of the surface occupied by marshes and swamps yet to be reclaimed and cleared. The growth of timber and vegetation is dense and luxurious wherever the land has not been brought under cultivation.

Certain physical divisions of the alluvial valley, conforming more or less closely to the main tributaries and connecting streams, are called "basins" and have received separate names, as the St. Francis Basin, the Yazoo Basin, the Tensas Basin, and the Atchafalaya Basin. A peculiar characteristic of the St. Francis Basin is the crumpled or fluted surface, indicated on the map by the long parallel marshes and pools or lakes, with intervening low ridges which run northeast and southwest in general direction. These are attributed to what is known as the New Madrid earthquake, which occurred about a hundred years ago, and to similar disturbances of an earlier date. For this reason the drainage system of the St. Francis Basin is somewhat irregular or abnormal, but the drainage systems of all the other basins down to the Red River are very similar to each other. While trending away from the immediate banks of the main river, the drainage and overflow water of each basin eventually returns to the river through the principal tributaries. Below the mouth of the Red River on the west bank and below Baton Rouge on the east the surface drainage is wholly away from the main river to bays and lakes that connect directly with the Gulf. There are a number of "diffluents" of considerable size leading out from the main river at various points, like the Atchafalaya, the Bayou La Fourche, and the Bayou Plaquemine. The two latter are now artificially closed at their heads. These originally constituted a delta system on a large scale, comparable to the delta region of the Nile in extent, but what is ordinarily known as the "delta of the Mississippi" is the "turkey foot" formation where the river discharges into the Gulf of Mexico, about a hundred miles below New Orleans. This alluvial valley area, having a total length of about a thousand miles and a mean width of perhaps fifty miles, is all subject to inundation during the flood stages of the Mississippi. It has a more or less scattered human population throughout the greater portion of its extent.

The navigable entrances to the Mississippi from the Gulf at the South Pass and the Southwest Pass have been deepened by the well known jetty system, assisted by dredging, to permit

sea-going vessels to reach New Orleans, but otherwise the Mississippi in its natural state affords ample depths for the needs of navigation at low water up to near the town of Lake Providence, 500 miles from its mouth. Above that point large expenditures have been made on contraction and regulating works at certain localities to improve the navigable depths. The main reliance now, however, is upon dredging, for which dredging plants of special design and unusually large capacity have been developed. By this means low water depths of 9 feet have been maintained all the way to the mouth of the Ohio at Cairo.

The alluvial material constituting the bed and banks of the river below Cairo is easily eroded and is therefore very unstable. Under the action of the current the banks are subject to constant changes, building out from deposit of sediment in certain localities and eroding and caving away in others, with attendant destruction of property on shore. Where these changes threatened especially detrimental effects, such as would result from a cut-off across the narrow neck of a long loop or bend in the river and the resulting increase in slope and velocity of current and disarrangement of the levee system of the locality, extensive works of bank protection have been undertaken. Such work consists of a pavement or revetment designed to protect the material of the bank from erosion and caving and therefore to insure stability of the bank line. Separate "spur dikes" placed at intervals have also been extensively tried for this purpose, notably to secure stability of the bank at New Orleans, but the present preference is for the continuous revetment. This revetment has been largely built of brush mattresses covered with stones or broken rock, though other materials have been experimented with. A number of miles of bank have been protected by this class of work.

The most extensive and important of all the artificial works connected with the Mississippi River is, however, the levee system; the artificial earthen embankments designed to retain floods and to protect the alluvial valley from overflow. This represents the largest investment and it is the feature at all times of the most concern to the inhabitants and property owners in the alluvial valley. The effectiveness and deficiencies of the levee system naturally constitute the subject of paramount interest during a crisis like the present. The building of the levees has been almost a continuous process, starting with the early settlements on the river, but the work has been particularly active with the assistance of large appropriations by the federal government during the last twenty years. The total length of these embankments along the main river is now about 1,500 miles, not counting the lines that have been abandoned and destroyed. Extensive lines of levees have also been built, mostly by the State and local organizations, along the principal tributaries. A close inspection of the map will show the numerous old and abandoned lines and fragments of levees rendered useless, mainly by changes in the bank line of the river and breaches in the former levee, making it necessary to fall back to a new line farther to the rear, and it will be apparent that the total length of lines that have been built largely exceeds the length that is now effective. These embankments are

practically all constructed of the material at hand—the alluvial earth originally deposited by the river itself—and they vary in cross section from quite insignificant dimensions to those corresponding to a net height of 40 feet or more, with side slopes of three to five on one.

Formerly there was much discussion and more or less controversy over what would be the effect as the levee system of the Mississippi approached such a degree of completeness as to protect all the lands of the valley that are susceptible to such protection from overflow. On the one hand it was contended that the discharge capacity of the river would be enlarged by the increased erosion resulting from confining the flood waters, and that the extreme flood height would not be increased unduly, if at all, and on the other it was maintained that flood heights would be increased by an amount that could not be predicted with any certainty. As a matter of fact, the grades to which it has been considered necessary to raise the levees of the lower river have been repeatedly made higher and during the present flood all previous records of flood heights have been broken. The loss of human life and the property damages have also been greater than in any previous flood. It must be remembered, however, that the levees are necessary and effective for *any* rise of the river above the “bank full” stage and that they therefore serve their purpose as a rule for a longer or shorter period every year. The flood heights that result in breaks and disaster are exceptional, occurring only at long intervals, and even when they do occur the greater part of the levee system performs its functions successfully, though the degree of success can scarcely be measured by the proportion between the length of the levee that remains intact and the length of the breaks, as has been sometimes represented. It has been said that effective control of the river will involve revetting all the banks that show a tendency to erosion and caving. This would involve something like 800 miles of such work and for complete control might require more. The work already done in this line is quite inconsiderable in comparison with this total.

The late flood conditions have emphasized one feature connected with the use of the river as a navigable highway for commercial purposes that is not always fully appreciated. The extreme annual variations in the height of the river surface have now reached a range of 50 feet or considerably more at practically all points from Cairo to the mouth of the Red River, and even as far down as New Orleans this range is over 21 feet. When it is remembered that these changes in the elevation of the water surface frequently require complete change of location of the landing places as well as change of level, the difficulty of providing “terminal facilities” for water transportation on the river and of adapting them to the varying conditions will be appreciated. In this respect at least rail transportation has decided advantages.

To bring this great river under practical control and to minimize the chances of breaks in the levee line during exceptional floods, or to localize and restrict the damages resulting from

breaks when they do occur, involves the most formidable problems in river engineering that man has yet been confronted with.

It is no reflection on the ability of the engineers who have been charged with the heavy responsibility of developing plans for the control of the river, or on the faithfulness with which they have performed their duties, to say that the present situation calls for careful consideration of all practical suggestions to improve the general security and to reduce the extent of the areas exposed to damage in extreme floods. A long period of time and a very large expenditure of money have been devoted to this work and those directly responsible for results will be the last ones to claim highest attainable success or to oppose trying modifications of methods that may be really promising of practical results and a betterment of conditions; but radical suggestions and those offered by persons with limited experience, or none at all, in this line of work must be received with much caution, particularly if a demonstration of the success or failure of such suggestions will involve a large outlay and considerable time and will be detrimental to present methods while the experiment is in progress. It is sometimes cheaper and more expedient to go ahead with a partially carried out practical plan than to change to another that might have proved better and less costly had it been adopted in the first instance.

The relations between the Mississippi River and the Great Lakes may not be very obvious to the casual observer, but in some respects they have at this time special interest for engineers in general and for those in particular who are concerned with the welfare of lake harbors and channels. The general map of the upper Mississippi shows the main features of the trough or valley through which the Illinois River and its tributary, the Des Plaines, now flow. This valley extends from the Mississippi at Grafton, a short distance above the mouth of the Missouri, practically all the way to Lake Michigan at Chicago and in its lower portions it has a close resemblance in width and general features to the neighboring valley of the Mississippi. The natural level of its floor near Chicago is only a few feet above that of Lake Michigan and the cutting of the Chicago Drainage Canal through this slight elevation makes a continuous drainage waterway from the lake to the Mississippi, consisting of the lower portion of the Chicago River—which formerly flowed into the lake and in which the current is now reversed—the artificial drainage canal, the lower portions of the Des Plaines River, and the greater part of the Illinois River. The evidences are very clear that this was the route of a former outlet from Lake Michigan when the southern portion of the lake was held at a higher level and other outlets were blocked by the ice sheet during the glacial period. The ancient beach lines corresponding to the former lake level can be easily traced in the vicinity of Chicago, and the broad and well defined valley through which the Illinois now flows contains, besides the river itself, a complicated system of lakes, ponds and sloughs that are not explained upon any satisfactory theory of the action of a stream of the size of the present one. These and other indications make it practically certain that an outlet stream from the

lake at the present site of Chicago of much greater volume than the present Illinois River, once flowed through this valley to the Mississippi, and the latter river might also have been of greater volume than at present. The present partially artificial outlet channel from Lake Michigan was constructed for the primary object of disposing of the sewage of Chicago, and it has been drawing off an average of about 5,000 cubic feet of water per second from the Great Lakes and discharging it into the Mississippi River system for some twelve years. The recent wide-spread interest in the question that has been aroused, in Canada as well as on the United States side of the boundary line, results from an application that was made early in the present year by the Chicago district to the federal authorities of the United States for authority under our general laws relative to navigable waters to increase the flow to 10,000 cubic feet per second. The profile of the waterway referred to has an abrupt descent in the upper portion from the level of Lake Michigan, which renders it practicable to develop water power in the vicinity of Lockport and Joliet, but below this locality the slope is very moderate for the greater part of the distance to the Mississippi. As is well known, it is represented that the primary object of the diversion of water from the lake is for the dilution and disposal of the sewage of Chicago and the protection of the city's water supply, which is taken from the lake, from contamination. Incidentally it is proposed to utilize the resulting water power as a contribution to the economy of the main undertaking, and it is also proposed eventually to take advantage of the possibilities of completing a deeper navigable channel connecting the Great Lakes with the Mississippi River by way of the Illinois. It should be remarked that which are the principal and which are the incidental objects to be attained cannot be very definitely stated, as this seems to depend somewhat on the point of view. That the question is one of immediate and vital importance to Chicago and vicinity there is no doubt. It is also one of wide-spread and far-reaching importance to a large population outside of Chicago, in both the United States and Canada, that would be affected by any material diminution in the levels or depletion of the flow through the present natural outlet of the system or the connecting channels, but the question may be considerably less simple than at first appears.

It is interesting to note that of several such ancient channels the Chicago outlet is the only one that practically permits of partial restoration, artificially, to a waterway, through which water can be drawn from the lakes by gravity alone. An ancient channel is found leading off from near Rome, N. Y., down the present valleys of the Mohawk and Hudson to the Atlantic, and another starts from Ft. Wayne, Indiana, and follows the present valley of the Wabash to the Ohio. There are indications that a minor outlet channel also existed formerly at Akron, in this State, and there was once a river of considerable volume flowing from near Saginaw in a southwesterly direction through the valley now occupied by the Grand River in Michigan and emptying into Lake Michigan when the Chicago outlet was in operation. There was also once an outlet flowing from the west end of Lake Superior

into the upper Mississippi. All these outlets belonged to a period when the lakes were partially covered by the ice sheet, when the water stood at higher levels, and when the shores were generally advanced beyond the present limits of the lakes. The change from ancient conditions in the level of the lake and in the corresponding position of the shore line has been less at Chicago than at any of the others, and this is the only locality where it is now at all practicable to tap off a large volume of water through an artificial channel, that offers opportunity for producing a considerable abrupt fall in the resulting stream and development of water power. It has been claimed that to utilize this outlet as proposed would be only in the nature of restoring natural conditions as they once existed. This is not, however, a complete or an entirely correct presentation of this feature of the case, since the ancient Chicago outlet never served as such for the complete chain of lakes as they exist today, and was never in operation naturally at the same time that the St. Lawrence outlet was flowing.

Mention should be made of the remarkably close approach to Lake Erie of the crest separating the Great Lakes drainage basin from that of the Mississippi system near Lake Chautauqua in western New York, where the shores of the two lakes are only about eight miles apart. The level of Lake Chautauqua is, however, about 730 feet above that of Lake Erie.

Considered independently and without regard to other interests, the physical and utilitarian possibilities of the Chicago outlet question are obvious. The effects of such an outlet on floods in the Mississippi will at least be under control and should probably not be serious anyway, while navigation and power development enterprises on the rivers affected will naturally be benefited rather than injured. The humanitarian side of the matter and the questions of the legal or natural right to take advantage of the only opportunity of the kind offered by nature to make such use of water from the Great Lakes, as well as the international complications involved, are wholly outside the proper scope of this paper, but it must be conceded that under present conditions the water of the Great Lakes is actually utilized by man to a comparatively slight extent. Only about one-half of one per cent of the mean outflow represents the present rate of consumption by cities that take their water supply from the lakes and the greater part of this is, of course, returned. The total volume of at least approximately pure fresh water continuously stored in the lakes would last, if it were possible to use it for this purpose, about 16,000 years at this rate of consumption.

Navigation is directly concerned only with a comparatively thin film of the water, less than 25 feet thick, extending over its upper surface, but it is very much concerned in preserving this thickness unimpaired, and in maintaining its upper level within certain limits throughout the respective lakes and channels. We shall find, however, that the percentage of the nearly one hundred thousand square miles of this film over the Great Lakes and connecting channels that is actually used by navigation is very small, even if we regard the part so used as all of the routes

commonly followed by vessels, with ample width for each route or track for navigation purposes. Even within these routes a vastly greater number of vessels than now use them could be accommodated, with proper enlargement of present facilities at special localities like the Soo Locks and the Detroit and St. Clair Rivers.

Power development depends entirely on utilizing the motion of the water, or to be more definite, its motion with respect to the surface of the earth at the locality considered, and this is the property of the water that is generally of little interest to navigation; or, to put it another way, it is the property that is generally detrimental to navigation rather than beneficial to it. Only a very insignificant part of the energy represented by the movement of the water of the lakes on its way to the sea is now utilized.

Even the water that leaves the lakes by evaporation performs an exceedingly useful and valuable function in its effects upon the climate of neighboring areas. There is at least strong probability that the changes of climate in certain areas in the western part of our own country and in other parts of the world whereby large areas formerly productive and habitable by man have now become arid and deserted were due to the drainage and drying up of large areas of fresh water that formerly existed in these localities.

A final thought in connection with the subject is as follows: These two great drainage systems are striking examples, each of the great class of natural inland water courses to which it belongs. The one, a vast network of streams without lakes or natural reservoirs, in which the main stem and the principal tributaries are subject to excessive variations in surface elevation and volume of discharge and to overflows and destructive floods, while the other is a system made up of a chain of great natural reservoirs with an outlet river which does not undergo such extensive changes. While the St. Lawrence is an unusually stable river, it does show a mean monthly discharge varying from 38 per cent below the average for 47 years to 40 per cent above the same average. A Board that recently considered the question of regulating lake levels and discharges from the outlets stated in its report, referring to natural conditions, that "no work of man ever has approached or ever will approach this perfection of regulation", and its conclusions relative to the practicability of improving natural conditions in respect to levels of the lakes without impairing the navigability of the outlet and connecting streams were not altogether favorable. Without reference to the question of concurrence with or dissent from these views, they do suggest rather forcibly that if difficulties are found in artificially improving conditions in the way of water levels and river discharges in the Great Lakes system, where the natural conditions would seem to be so favorable for artificial works of improvement, what can be said of the suggestion that has been seriously made that regulation of the Mississippi mainly or largely by artificial reservoirs be attempted? The drainage basin of the Mississippi is about four times as large as that of the St. Lawrence system, and while the mean annual rainfall per unit of total area of the former is less,

the total annual discharge of the Mississippi is at least three times that of the St. Lawrence. Without regard to other difficulties, where would sites be found for reservoirs of sufficient capacity to have any practical effect in controlling the floods in the lower Mississippi like the one which now prevails?

The waters of the Great Lakes constitute a magnificent and only partially developed asset. To utilize this asset to the highest degree practicable for human needs and to reconcile and harmonize the several demands upon it that are necessarily more or less in conflict, constitutes a problem for the engineer that is worthy of his closest study and best efforts. There is good reason to believe that it is possible to greatly increase the percentage of net efficiency in this utilization as well as the total net result with due regard to both conservation and waste prevention; and that the navigation utilization and efficiency will be increased by fair and broad-minded efforts in this direction to at least as great a degree as will be the improvement in the efficiency of the other utilities.

May 14, 1912.

NOTE.—One way of stating the present phase of the lake level question is here offered as follows: The levels of the lakes and the volume of flow in the outlet and connecting channels are subject to certain approximately regular variations. There are annual changes conforming more or less closely to a general law or mean curve, as has been determined by accurate observations that have been continued for about fifty years, and there are also what appear to be cyclical variations extending over periods of several years each, but the observations are not yet sufficiently extended to determine fully the laws of these larger periods. At certain times the levels and volumes of flow are in excess of any need of man yet proposed; at other times there are deficiencies, but the general average appears to show a large surplus. Is it practicable by artificial works to flatten out or modify the curve of variations so as to compensate for the deficiencies and still leave the surplus equal to or greater than the amount that it may be desired to take artificially from the lakes, and if so, what will be the cost and how should the cost be apportioned? The available evidence does not yet show conclusively whether or not there will be a continual tendency to lower the lakes below a permissible limit under present conditions.

River and Harbor Improvement from an Esthetic Standpoint

BY CHAS. W. HOPKINSON

MR. PRESIDENT AND GENTLEMEN OF THE CLUB:—

It has become a truism that one of the greatest marvels of the age is the growth and development of our cities. It is said that one hundred years ago only 4 per cent of the people of the United States dwelt in cities, but that now it has increased to nearly 40 per cent of our population. This has brought new conditions into our lives.

We have noticed how easy it has been for the cities to grow large; we are equally astonished to see how poorly they have grown large from an artistic standpoint. It is no idle thought to say that American cities have not yet attained any artistic strength or standing; in fact, they were the by-word of the world until very recently. But the very growing interest in this subject, the very great attention given to it throughout the country, has fortunately induced many to take up the serious work of beautification.

Only one city in this country has been born full fledged with a development plan. As you know, that is the city of Washington. Major Pierre Charles L'Enfant in Washington's time was instructed by Washington to evolve an ideal city. He planned the city of Washington entirely on paper—a city which, in his mind, should ultimately take in a population one and one-third times as large as Paris then was. That shows the imaginative power and appreciativeness of Major L'Enfant at that time. It is a pleasure to note that the city of Washington has gone back to that plan and is also working out a scheme which I saw recently, of extending the environs of Washington by forest and public parkway and other improvements, so that the city will go on to a much larger development than even Major L'Enfant himself planned, although still in the spirit of his conception.

The mall in Washington was to be the great center of the city. It was to be a wedge-shaped park with two great avenues bounding it. The city itself was practically planned as a gridiron city, the streets laid out for the most part in parallels and at right angles; but it was interspersed with diagonal roads forming civic centers and affording abundance of opportunities for beautification. This deliberate planning of intersections for future monuments and small parks makes the work easier for future generations. When the engineering of the streets and areas is not done in a way to easily lend itself to the proper esthetic growth of the future, the city is necessarily greatly hampered. If, therefore, the laying out of a city is remiss in this direction, no time should be lost

in endeavoring to overcome the difficulty by opening the proper diagonals before the congestion which inevitably comes makes the work doubly expensive and difficult.

They who love Cleveland and admire our pleasant streets, lined with beautiful shade trees and private homes, sometimes imagine we have an artistic city; but this is not so in the main. It is time we should extend our parks and boulevards, though they are very creditable and attractive and are rapidly approaching the best of their kind in the country. But our city outside of the actual parks and boulevards is singularly wanting in good planning, good vistas, proper civic centers, etc. Some of us were astonished when it became the sixth city. So incoherently had the city grown that its great size was not noticed readily. With this increase in numbers has come all sorts of utilitarian developments; increased railways and switch yards are coming, larger manufactories are settling here, and everything is teeming with new business and facilities for handling it. All this means great financial gain to Cleveland. Yet we must not be content with this alone. To sit still and let all these practical elements rule absolutely is to lose our opportunity. Some plan should be at once devised as a background for the coming business and people so that our growth may be shaped along logical, systematic lines rather than along the lines of least resistance as now.

But I am not to speak of the possible civic centers, diagonal streets, etc., of our city, but rather of our river and harbor propositions. If there is anything artistic about them in their present condition, I have failed to discover it; I believe most of us consider it a nearly hopeless task. To stand on the banks of the Cuyahoga valley and look down into the bottoms is sufficient to well nigh discourage the most optimistic. The crude bridges without the slightest endeavor at embellishment of either the swing parts or approaches, the ugly, rotting wooden docks, the fearfully crooked river which is not only most unsafe to navigate and impractical in every way, but is filthy in the extreme—all confirm this view. Indeed so great is the improvement required to bring order out of chaos in the valley and so fundamental the necessary changes with the cost proportionally large, that I shall not further dwell on this phase of the beautification of our city at this time, but will rather turn to that more promising problem of the immediate future—the lake front.

It does not seem to me, though, that Cleveland is any worse off than other cities which have sought to be beautiful. There are elements here which are not to be despised. In the first place, we have beautiful Edgewater Park, quite a charming small park; interesting at least from the standpoint of giving people a chance to get to the lake. There will be no smoke stacks along the frontage of Edgewater Park.

West—there is a high bluff—which bluff has been taken up by homesteads, and will probably become so firmly established in homes that it cannot be claimed by lumber yards and railroads. So we may expect that stretch of three or four miles may be saved.

Then, we have Rocky River and valley. Some of us think it is a joke, but I believe it is destined to make for the city of

Cleveland a very charming and important place for the people of this city to boat in, and to use as an outing and recreation grounds. It should be taken in hand at once and properly planned for future development and beautifying.

What have we east? We have Gordon Park. It is not very large, but it acts as a breathing spot for the people east of the river. I would like to see Mr. Humphrey's park, or some land similar, in the near future made also a green spot for the pleasure and the comfort of the people of Cleveland. When that is done, and probably it will be done sometime, there will then be a chain of parks on the lake front which would be of permanent and increasing value to our growing city.

Another element enters in; the group plan. Fortunately the group plan has been placed on the waterfront. This is wise, as our greatest artistic asset is Lake Erie. The mall, as planned for Cleveland, looks very unsightly now, but give us time. It will be ultimately one of the sights of the world, with its southern narrow end touching Superior avenue and widening as it runs north towards the lake. It will be a beautiful civic center and could be made the approach to Cleveland from the lake in an ideally, artistic way.

There is thus planned a great axis from Superior avenue just east of the Federal building, leading straight to the lake. The natural and obvious thing to do is to continue this axis into the harbor and make a monumental water entrance at which passenger boats and pleasure crafts could land. Such an approach could be made one of the sights of the world, if properly carried out. But already business is crowding into the lake front break-water basin. Piers for freighters, coal hoisting machinery and other unsightly structures are appearing. If not taken in hand soon our dreams of a great water approach will be increasingly difficult of fulfillment.

We are not the only city that has struggled with the lake front proposition. We have not, as Toronto has, an island forming a lagoon in our lake front. If we had, it would be a splendid thing. We have instead an open, unprotected coast. One other city along the great lakes has tried to make up for that loss of natural lagoons. They had disputed land; were in dispute with the railroads; they had politics to contend with; they had land that was unsightly. But they had money to put into it and they have solved it in a way that I think Cleveland might take a lesson from. I refer to the city of Chicago. At the great park there opposite the Auditorium, they propose to have a yacht harbor. I do not know the streets sufficiently to tell you, but up back from the lake front is to be the civic center. The yacht harbor will be on the axis line of this civic center and will continue to the Chicago river mouth on the north and to the Calumet river on the south and will be a series of continuous lagoons formed by an outer strip of land—I think this land itself will be something like one thousand feet wide. All this space between the island and the main land will be used for yachting

and for racing, so that in the course of time it is supposed that this inner pleasure harbor will become of national repute. What a splendid thing it would be for Cleveland if we could form a series of artificial islands or breakwater off the shore extending from the river to beyond Gordon Park. Thousands of young men would then have boats and canoes, and I am sure it could be so combined as to allow the manufacturing concerns to still have such access to the waterfront as they would need for their manufacturing purposes.

RIVER AND HARBOR IMPROVEMENT.

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The Engineering of Men

A Talk by WILLARD BEAHAN

"The most difficult and at the same time the most important branch of engineering is the engineering of men."

I shall speak of the engineering of men tonight, mainly from the standpoint of the engineer and as a member of this Society. If one endeavored to speak of the problems of labor and capital, this hour would be all too short. As a caption for this paper I use a law laid down by Robert Stephenson, one of the fathers of engineering. That statement is nearly a century old. Robert Stephenson was the son of George Stephenson, who was the father of railroad engineering, and who built the Rocket. The first locomotive that was run in this country, was built by Stephenson and his companies. In those days, civil engineering was not at all subdivided. We had civil and military engineering. We did not have any division between mechanical and civil engineering.

George Stephenson built the Rocket, as you know, in 1826. He had become prominent as an engineer of railroads, inventor and promotor. He really became the first railway engineer of the world. Now this George Stephenson laid down a law some hundred years ago and we have not yet reached to the horizon of that law. It is this: In speaking of the means of transportation, he said:

"Competition is impossible wherever combination is possible."

You put that law alongside the law which I have first laid down, given by his son, and you have shown the engineer of today his two largest problems, and you have given a horizon in each of those problems which is broader than many of our visions can compass. George Stephenson did not live a great while after the Rocket was built, but his son, Robert, lived a long time, and it was in the later years of his life that he laid down this first rule for us. I want to call your attention to this fact—that these fathers of engineering, father and son, and the men of their time—not only made the plans of their engines, of their bridges, and their roads, but they promoted the project through Parliament and before Boards of Trades. They raised the money; they built the road; they handled their own men; and they completed the work.

That was the way our profession started. As we grew, and especially in America, the development of the country was such that our profession could not possibly keep pace with it. The

result was that, more and more, that part of engineering which could be lopped off was taken away. The legal end, the promoting end, the financing end were the first to go. Not so many years ago, I can quite easily remember it, contractors came to be general in this country—we still have with us a few of the engineers who never employed contractors. Captain James B. Eads, who built the St. Louis bridge, the steel arch which is the biggest steel arch, I think, in the world, was foremost among those who promoted that bridge. He convinced the people it could be built, that it ought to be built, and he convinced Congress. Mr. Eads, to a marked degree, prosecuted his work in this country as Stephenson did in England. General Grenville M. Dodge, who commanded the 16th Army Corps during the war, and made a mark for himself with Grant for his rapid construction of bridges, was also a great railroad engineer. It was my privilege to serve under General Dodge in the 80's in Texas. To a large extent, he planned, financed and completed his own works through improvement companies, which were really the general contractors.

I maintain tonight that we have drifted too far away from the ideals of the fathers in engineering, and that all this is because we were driven to it. It came to pass, not many years ago, that about all that an engineer did was to make the plans, drive stakes and let the contracts, and we have finally come, my brethren, until, as a prominent labor man lately said to me, "that about all that a railroad company can say now in labor questions is to pay the bills".

We have drifted so far away from the ideals of the fathers that we are of much less use to the world than we should be, and I wish to say that this Society saw that a few years ago, and the very fact that we are domiciled in the Chamber of Commerce is evidence of our new vision. The making of a plan, the letting of a contract, and driving some stakes, which are followed more or less closely, is not the highest form of engineering; and if I do not say anything else tonight that you young men will remember, I want to say that we are not coming up to the ideal of the Stephensons. We have spent too much time in testing materials, and work of that nature, and we have spent very little time in engineering the men. We have turned that over to the men with thick shoe soles, brass watch chains and heavy voices. The most important branch of engineering is the engineering of men, and that is the branch that we have turned over to other people.

General Laws.

The first law I would lay down in the engineering of men is a very old law, but in my judgment it is fundamental. Some call it the Golden Rule. You will find it in the 6th Chapter of Luke along about the 31st verse. Freely it reads:

"Do unto others as you would that they should do unto you."

As engineers, we have gotten a good way from that. We have found out, I suppose, that it takes quite a brave man to lay down that rule in the handling of men; but when as an employer

of labor, or a supervisor of it, I forget that law and fail to treat those men as I would like to be treated I am bound to have trouble.

The second law is that very good one of the army officers of West Point, and is compassed in that little phrase they term "caring for their men", meaning looking after their needs, their wants, their happiness, their welfare. I would place that alongside of the "Golden Rule". An army officer, be he never so brave, is not a success if he neglects to take care of his men. The high water mark of warfare on this continent was at the battle of Gettysburg. In Pickett's charge, Gen. Hancock, with the second army corps, was withstanding that charge. Hancock was wounded a few minutes before Pickett started, and he was wounded while writing on the horn of his saddle an order to his commissary to bring up fresh meat for his soldiers for supper that night. Even in the awful stress of that critical moment, Hancock cared for his men.

I think that bears me out that the care of men is one of the first laws to be observed in the engineering of men. I have heard many men from West Point say: "We have many men who can *fight* a brigade, but fewer who can *handle* a brigade." It is easier to lead a charge than it is to take care of a brigade two weeks. In the engineering of men this is the second principle I would state.

The third law which I would have you remember is this: Men carried on your pay-roll must be carried on your heart. Whether you pay the men or not; if you have to sign the roll on which these men's names go in, month by month, you must carry those men on your heart. You are responsible for their welfare, you are responsible to see that they get their pay, the last penny—and even a little further than that—the last penny that *they think they ought to have*. You are responsible to see that they get their money in time. That they are promoted; that their rates of pay are equitable, especially of the younger ones. More than that, you are responsible for the married men, especially. If he is a father, so far as you can, allow him to work as near home as the interest of the company will permit, if it does make you a good deal more trouble. That is what I mean by carrying them on your heart. If you don't do that you are not an engineer of men. If you don't do that the Almighty will some day call on you to know why you did not. If you did that there would not be so many strikes.

Principles in Organization.

In the organization of your work and blocking it out, there are three things of prime importance: Personality, organization and treatment. If I may reverently paraphrase—"There abideth personality, organization and treatment, these three, but the greatest of these is *treatment*."

The personality of the superior at the head of an organization is a very important matter. The bigger the organization, relatively, the more important it is to have the right kind of man,

but even if there be but one gang of men, the personality of that gang boss is very important.

In an organization, I believe in military ideals. If you can imagine a military organization without the shoulder strap, then that is what I believe in, and I have worked with army officers a great deal. There must be discipline, there must be responsibility placed upon one head, and it must be recognized. If you cannot respect the man above you, you must at least respect his position. Don't forget that. That is an army idea.

It does not follow that the ranking engineer of an organization is the best engineer. Let me illustrate: We were building the Texas Pacific in the early 80's, and as these men have passed away I can mention them. One of the men, Major Washburn, a West Pointer, was in the artillery at Little Round Top at the battle of Gettysburg. There was at Fort Worth, Texas, where we had our headquarters, a Major Patton.—I think he was a Kentucky major, I do not think he ever was in any army. (Laughter.)—There was in our organization a Mr. Lawrence, who had seen splendid service on the Union side and was a very brilliant, brainy locating engineer, but sometimes given to drinking too much. He happened to be in Fort Worth, and I suppose had been drinking, and said one night that he was a better locating engineer than Major Washburn. Major Patton heard this remark, and he, wishing to curry favor, said to Major Washburn: "Major Lawrence says that he is a better locating engineer than you are." Major Washburn replied: "I believe that is true." Whereupon the Kentucky major said: "Why, do I understand that you would have a man under you who claims to be a better engineer than you are?" "Oh, yes, I am very glad to have them. I wish I had more of them. Now, for instance, there is Mr. McL., who is a better construction engineer than I am; Mr. L., who is a better maintenance engineer." "That is very strange," said Patton. "No," said Washburn, "they are all better engineers than I am, but I suppose that the people in New York, General Dodge, the President of our Company, consider that on the whole *I am the best man for Chief Engineer.*" He was the best all-around man. He was quite good in all departments. He was a fine organizer. He knew how to handle men.

The worst mistake we make today in organizations is experimentation. In railroads it is pitiable. I saw but a few winters ago in *The Railroad Gazette*, an entire page occupied with the re-organization of a certain railroad in a certain way and giving the reasons for it. On the next page, another road, it was announced, was re-organizing from the organization which the first road were abandoning, as they were instituting something else. One company or the other was making a mistake. One company should not have abandoned it, or the other company should not have taken it up. We are in the kindergarten stage so far as that is concerned. We men in railroad service know it means a great deal of expense, a great deal of distress, and it takes us a long while to get our bearings.

3. The third great requisite in organization is treatment. I

think if we could get back—which we never can—to the English idea of master and servant, we would be doing something very much to be desired. It would save us a great deal of money and do away with a great deal of the friction. The master and servant idea was this: A man hired a boy, took him into his family, fed him, looked after him, paid him, and he lived with that boy for a term of years. We cannot do that now, but some one must come pretty near doing that for us. We must pick out the men to whom to delegate it. I suppose that many of you think that it is entirely visionary and impractical. No, it is not. The Chicago & Northwestern Road has come very near that idea to-night, because Mr. Hughitt, Chairman of the Board, believes in it. Here is Mr. Hughitt's rule: If a man has been in the employ of the company five years he cannot be discharged without a hearing. If the charge against the man is incompetency, Mr. Hughitt would say, "It seems to me it has taken you entirely too long to find this out," or, "You should have found it out before five years." That applies to even such minor positions as brakeman. If a man thinks he has been improperly used on the Northwestern he can appeal to the President and the President investigates. When I was there I said to my informant, "I should think it would take all the President's time." He said, "Oh, he don't get so many cases. We all give heed to that." (Laughter.) Good treatment will win devotion. A raise in pay will not quickly win devotion. We think if the company would only allow us to pay bigger salaries, we would get and keep the best men in the country. There is no greater fallacy. It confesses our weakness.

Engineering Organization.

The simplest form of organization is that for the project engineer. The first requisite, in my judgment, is to put a man in charge of that project with engineering education, whether he acquired it in college or somewhere else. I do not believe in putting a man on a job who has not been in that particular kind of work. I do not believe in putting him in charge because he is simply brilliant. I would put a man in charge of that work who has had experience in that kind of work, and I want him to be forty years of age. I was put in charge at twenty-five. He must know human nature. He must be in full charge of all the features of the work.

"Well," you will say, "that is difficult." Very well, there is the first difficulty you are going to meet. If you divide the responsibility at all, then when there is a mistake made there is no one you can hold responsible. Your Chief of Party should always be able to do any work under him fairly well. In order to do that, he must practically come up through the ranks. His first assistant must be but a little less able. He must be an understudy. In temporary illness he must be able to carry on the work. There should always be an understudy in *every position* so far as that is concerned.

Allow me to say in parenthesis that I have great sympathy for young men whose fathers are Vice Presidents or large stock-

holders. I am not one of those who degrade that kind of man. I have seen some sad things in that direction. Don't make the mistake of putting him in work he cannot do, and then hiring another man to do the work. You are trying to curry favor and build yourself up at the expense of that young man just because his father is Vice President. I have had more than one young man come to me and beg of me not to let the men know his father is Vice President. Plenty of men in this country are handicapped by their wealthy, or their great fathers. I am sorry for them.

Have your office for this project or piece of work in the middle of your work. If it is a piece of construction work, have your best assistant in charge of the office, never the Chief Clerk. This has been the day of the Chief Clerk, and he is passing. The rubber stamp and the Chief Clerk have cost many a heart ache and many a thousand dollars. It comes from the fact that you and I in charge of the work are overloaded and are jealous of our understudy. "If we get a good assistant, he will get our job," we think, so we put a Chief Clerk in and somebody else gets our job. Our centralization is killing us. It killed Harri-man. You will rule your work—this project I have outlined for you—if you rule it at all, by reason of your engineering, and your manhood. If you are that kind of man it is easy to control the project and have your success.

The head of even the smaller engineering projects or enterprises must "sit tight". Troublesome times will come. With your work well lined up and the best of engineers and labor there will come times that try men's souls. Then you need to have faith and the staying qualities of that heroic sergeant of whom Kipling says:

"He's just as sick as they are,
His heart is like to split,
But he works 'em, works 'em, works 'em
Till he feels 'em take the bit;
The rest is holding steady
Till the watchful bugles play,
And he lifts 'em, lifts 'em, lifts 'em,
Through the charge that wins the day."

Labor Problems.

The engineer of men in the broadest sense must be two-fold, an engineer, and a student of men. An engineer of design is not an engineer of men. He is an engineer of plan, of specifications and of material. An engineer on the frontier, as General Dodge told us, had to be an engineer of men, or the Indians would get him and his men both. (Laughter.) The man, I have said, who is in charge must have absolute charge, and in the control of men that is the first thing.

If you expect to control labor in general—and I am now speaking of ordinary labor—three things are necessary: First, there must be no dispute but what you have the authority, and

the men must know that. You are in authority, you are the boss, if you are handling men, whether a few or a few hundred men. Battles have been won by a poor commanding officer, but no battle was ever won by a debating society.

A second requirement is that you must be absolutely right—legally, morally right. That the right is on your side and beyond dispute. I can best illustrate my meaning by an incident.

In 1898, I was superintendent of the Cascade Tunnel for Mr. James J. Hill, of the Great Northern Railway. It was a company job. I was superintendent, another man was engineer. We went up there in August. We started in with no organization and no men; cleared the ground, got a few men at a time—we gathered there four hundred men—driving the tunnel two and three-quarters miles, working from a camp at each end. We boarded the men. We had our own store, and our own doctor and hospital—a little community by ourselves. There were some saloonkeepers who came in—we held them off our certain reservation. We made our rules that applied to them. We had our own camp bosses. There was a county line crossing at the center of the tunnel and each of the camp bosses was sworn in as a deputy sheriff in his own camp county. They had been peace officers at home. While all the men did not know it, I was deputy sheriff in each county. When a man got bad, we locked him up, and wired for the sheriff to come and get him.

The incident I am about to relate happened in February. I had not been put in charge of the dining rooms. We had an engineer in charge of maintenance, and thinking the work would be heavy for me, the dining rooms were still in his charge. He had put there as commissary clerk a conductor from the dining car service. Now, of course, he would not know how to feed *these* men. He got us in trouble. The snow was very deep, lying twenty feet on the level. The only trails were where we walked. There was no such thing as straying out of the path. The men did not know I was in that particular camp. I had just passed the dining room—our men worked in three eight-hour shifts—I saw the men coming out of two of the company's quarterhouses. There were one hundred men. It was snowing very hard. I suspected they were coming out for mischief. They came up the trail, going toward the dining room. I waited for them:

"How are you, boys? Going up to the dining room? A little early for dinner, aren't you?" This was about half past two, and the next meal was at four o'clock.

"Yes, but we have a little business up there," one of them said.

"Well, am I invited?"

"I don't know about that," was the reply.

"What's going on?" I asked.

"We are going up there to hang the commissary clerk."
(Laughter.)

"Oh, well, I don't think it is very polite of you to neglect to invite me when there are such festivities as that. What's the matter with the commissary clerk?"

Really, it didn't amount to anything. I asked them some questions, got all the facts.

"Now," I said, "do you think you are treating the company right to create a scandal of this sort, as it will do? Aren't you acting like fools here? Now, suppose I let you go up there and do it, which I am not going to let you do, you can't get off this right-of-way without we allow you to. The snow is twenty feet deep, you can't walk down the track. We will load you up and send you down to Seattle; a lot of you will get hung. Another thing, how will this look when it gets to St. Paul tomorrow morning? Is that treating the company right? You are supposed to be American citizens. You think you are fit to be citizens and voters in this country. This man hasn't done anything. Do you think you are treating me right? I am the superintendent out here, and I am responsible.

"Well, we ain't got anything against you."

"You haven't! Now, you fellows go back into your 'quarters', and if you have a grievance I will listen to you, and if you don't, I will have to strike first."

I talked to them pleasantly, reasonably. Some eighty men in the background wandered back. They hadn't anything against me. They didn't want to be hung. The leaders wouldn't stir. I suppose there were some ten to fifteen of them. I could not do anything with them. The first leader I knew very well. I had routed him once before, a Cornish miner, surly and thick-headed; another was an Irishman, my own nationality. No use to argue with those men, they were beyond argument. There they were, the snow was coming down pretty lively.

"Now," I asked, "have you got anything more to say? You fellows go back to your bunk house." Not a man moved. I drew my toe across the path, and stepped back a pace or two. "That is all I have to say, come ahead, you can kill me at the last, but just as sure as you cross that mark I will kill six of you, and I think I can pick out the six who started this, and I will kill them first." They looked at me for a minute or two, and the Irishman said:

"Well, now, 'Super', what is your proposition?" I said: "You go back to your bunk house just as I have told you a dozen times, and in twenty minutes you send a committee around to my room at D quarters and I will tell you what I will do." They went back to the bunk house. Then I went back to the cook house and saw the commissary clerk. In twenty minutes I met their committee, as agreed, and said:

"Now, the main trouble is too small a cooking range; I will have another here as soon as I can."

"That is all right; we think that is fair," they said. That ended it.

Having the authority, and being in the right, the final thing in handling labor is that you must not be afraid. Let a hundred men come together, average men, and it is said that in thirty days one of that hundred men will be the leader. Now, I never knew a leader of that sort to be a coward. So, as an engineer of men, you must have that leadership quality. You will be surprised to

see what you can do with it. I believe many of us fail right there. We are afraid. Afraid of the law; afraid of damages; physical fear; fear something is going to happen to us. Right makes might more than we think.

May I again illustrate from experience?

We were building the Texas & Pacific Railway for Mr. Gould in the early 80's. We began at Fort Worth and worked toward El Paso, the other terminal. By the time we had reached the staked plans, the Southern Pacific, our rivals, were nearing El Paso. We started then a second construction force out of El Paso to secure the choice of route down the Rio Grande river and up the best tributary suited to our purpose. To reach this grading, we must first build through Carizzo Pass of the Apache mountains, 125 miles east of El Paso. Though but a youngster then, I was resident engineer of the work for ninety miles, including the pass.

We had been at work some five months at the time of the incident I now relate. The pass could be traveled into or out of at the ends only. At the upper end was a grading camp of about 100 men—mostly Irishmen. At the lower end was a camp of a little greater number of Mexicans. In the center and just across the grade from the engineers' camp was a camp of sixty Chinamen. They had served their time of several years to the six companies and were free of any obligation. They were tall, strapping fellows, entirely different from our laundry men and each carried a pistol.

In this cosmopolitan camp there had been no liquor in the entire five months we had been at work. The Irishmen were certainly dry. The Mexicans resembled them in that one respect. The Chinamen were hemmed in, were armed and nobody loved them. Into this canyon there drove, one summer afternoon, two big wagonloads of whiskey, accompanied by six heavily armed men. They unhitched their teams about in the center of the pass and were neighbors to the Engineers and the Orientals. This saloon outfit had been the pest of the grading on the east end for two years. The track had gotten far enough across the staked plains so the proprietor got across without dying of thirst. The contractor in Carizzo Pass tried to coax him to move on west. He tried to buy him off, all to no purpose.

My work compelled me to ride nights, as the Apache Indians were bad. The next morning I reached that camp. The contractor and myself held a pow-wow, the engineer party being present. We decided what men we could depend upon and sent them word to be ready. The contractor started moving his pile of grain sacks and piled them in a crescent and left spaces for loop holes where needed between the sacks.

I wrote out a notice stating the company's case, that the saloon interfered with our business, menaced our lives, owing to the mixed races, trespassed on our land and that we forbid his camping there. I signed it for and in the name of the company. I again saddled up the grand old Kentucky horse I then rode, buckled my weapons around me, rode down to their wagons and called for the boss of the outfit.

There rose up a splendid specimen of physical mankind, wearing a fine pair of ivory-handled, 44-caliber six-shooters. I handed him the notice. He read it twice. As he handed it back he said: "I suppose you know I'm not going to pay any attention to that. What's more, I've heard of you and I'm not afraid of you." I was encouraged. I saw there was some force to that notice and that fear was in his mind. Meanwhile the six ruffians had gathered around me, all around. I sat with my arms folded. I told them I was building a railroad. That we could not lay tracks *around* the heavy work in that pass. That the grading was going to be done before the tracks reached it. That I was hired to see to it and that they were getting in the way. I advised them to get out of that pass. If they did not, there was no telling what night an Indian outbreak would occur and they would be sure to get hurt. I made it clear to them that I was some prophet in Apache *lore* and they saw what I meant. Then I rode off and never looked back. In an hour they hauled their wagons some miles up above the pass and we left them there the rest of the season. I had happened to notify them in the name of the company that their business interfered with ours and did it before their camp was established, a good legal point which I blundered upon. I showed them I was not afraid and was in earnest. They fell back. They always will. In Grant's first battle, he happened to think that the enemy was probably as badly scared as he was and that the enemy's cause was less just. So, in the engineering of men, when you must cope with the lawless element, have right entirely and clearly on your side. Then sail in. If you do not run, the other fellow must, finally. If this incident should catch the eye of any of the old T. & P. men, I wish to say that that fellow could have been tamed two years before, *I think*, and by the same method.

A labor union is not omnipotent. If you will read in the last *Century* for May, in *The Topics of the Times*, you will find that no one claims any more than 25 per cent of the labor in this country is organized. They tell you, too, that a labor union must have its own way and that the minority of labor must rule the majority of labor. Personally, I am ashamed of the way we allow labor unions to dominate us today. I think I see the turning of the tide. Labor unions are not at all what they were five years ago, and unless I mistake not, we are going to see much less trouble with labor unions than we have had. It is a fact determined by the Commissioner of Commerce in the east that 10 per cent of our labor is idle all the time; of the 90 per cent employed, one-third is idle some part of each year. That is a sad thought. I believe honestly that what we need in this country today is not higher wages, but steadier work. I believe that labor unions are working in the other direction. What they want is higher wages and more men put on for a part of a time—the iron-clad pay-roll—by that I mean uniform pay-rolls—has worked great mischief in this country, and, in my judgment, is a confession of weakness on the part of the employer and engineer. Why should we pay an Italian laborer, who cannot understand our language at all and who is under size, as much as we pay a Scandinavian or German,

who speaks our language and who eats as much as anybody? (Laughter.) Is there any sense in it? We do it to save trouble. If you are like I am, you do it because you are too lazy to do anything else.

Now, I ran against this iron-clad pay-roll idea, when a youngster, in Texas. We had been building the Texas & Pacific, and the farther we got away from Fort Worth, the poorer our engineering employes were, because other roads came in and took our best men. It was necessary to do something, or our work would be badly crippled. They brought me back to Fort Worth, to build toward Denver. I spoke to the Chief Engineer and said: "Let me fix the rate of pay," and explained by ideas. He said: "I fear you will have trouble; but, all right, try it out." I did; I worked for the company seven years after that, and I always fixed the rate of pay of the engineers under me. I always kept the best men, the poorer men I did not give so much. On the average, I paid less than the company gave. I would start the new men at the lower rate of pay. I said: "I can raise you, and if you think you are not being paid enough, tell me." When I handled engineering parties I always fixed the engineers' pay, and *I never had an engineer quit nor ask more pay or less work.*

In handling laborers and mechanics for contractors, we would start a man at \$1.50 and when he had worked thirty days, he was raised to \$1.65. If he thought he was a little better than the average, he could ask his foreman to give him \$1.75, and if the foreman thought that was best, he could recommend it. If the foreman would not do it, the man could ask the superintendent to raise his pay. One-third of our men got the \$1.75 and always stuck, because we were giving them a little better pay than they could get elsewhere in that community. We never had a strike. If it commenced to get a little bit turbulent, these men getting high wages would tell us voluntarily who made the trouble. I don't believe in the iron-clad pay-roll. If a man cannot speak my language, I would pay him less, or I would not have him at all, and the high-priced men are the cheapest men we have.

In recapitulation I would say that as engineers we have drifted from our moorings. We must get back to the view of the Stephensons and the fathers of engineering, and not only be engineers of design, but engineers of men. To do so, two things are necessary: The courage of our convictions, and a knowledge of the teachings of the Carpenter of Nazareth 1,900 years ago, "Love your neighbor as yourself". Now, your employe should always be your *near* neighbor.

The military organization is a good foundation, and coupled with it is the broad law of the army officer to "care for his men".

Strikes are blind barbarism and economic waste. Engineers can do more to prevent and more to stop them than any other class of professional men. It is our duty. Shall we then be men of affairs in this as in so many other ways now? The present time is most opportune. The labor strike is failing and passing. May we, as engineers, inherit our own kingdom and bless mankind? May we take upon our shoulders this phase of the white

man's burden? I commend to my brother engineers these lines of Foss as our watchword:

“There are hermit souls that live withdrawn,
In the place of their self-content;
There are souls like stars, that live apart,
In a fellowless firmament;
There are pioneer souls, that blaze their path,
Where the highway never ran;
But let *me* live by the side of the road
And be a friend to man.”

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Steel and its Heat Treatment

By R. R. ABBETT

Steel is an alloy. In its most simple form it is composed of two constituents, iron and carbide of iron.

Heat treatment, defined according to modern practice, consists of alternate processes of heating and cooling conducted in such a way that the useful properties of the steel are increased in value. This treatment may increase all or part of the properties independently of each other or it may increase some of the properties at the expense of others.

If a piece of platinum be placed in a furnace which is at a temperature of say 2,000 degrees Fahrenheit, it will heat at a uniform rate until it attains the temperature of the furnace, that

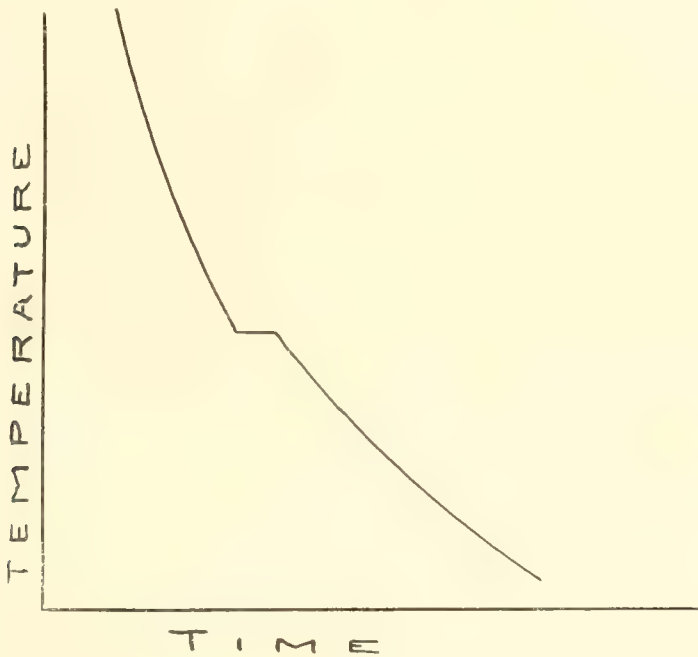


FIG. 1.

is to say, if a heating curve be plotted with time as the abscissa and temperature as the ordinate, it will consist of a smooth curve. With a piece of steel instead of platinum this will not be so; the curve will contain one or more jogs depending upon the relative amounts of iron and carbide of iron and to a less extent upon the presence of other elements. The above facts will be true upon cooling as well as upon heating. The temperatures at which these jogs occur are known as *critical temperatures* or *critical points*. A little consideration will show that these jogs are caused by some internal change taking place in the steel either requiring or giving up energy. (Fig. 1.)

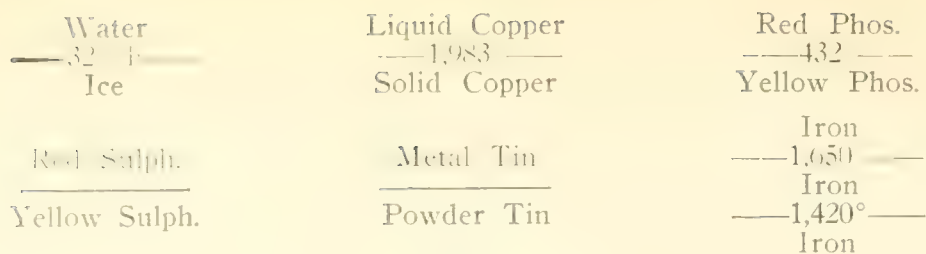


FIG. 2.

Some analogous cases in other alloys or solutions will probably make this more clear. (Fig. 2.) The change between water and ice occurs at 32 degrees Fahr. This point might be considered a critical point for water. At this temperature the heating and cooling curve show a jog. Liquid copper changes to solid copper at a temperature of 1,983 degrees Fahr. In both of these cases the physical properties of the substance above the change point and below it are entirely different; the specific heat, specific gravity, hardness, color, and state of matter (liquid and solid) are different. Now it might easily be conceived that a critical change could take place accompanied by all the above changes without the change in state of matter. The next four examples of Fig. 2 show such changes. Yellow phosphorus, which is inflammable and poisonous, can be changed into a red form by heating it to 432 degrees; this red form is neither inflammable nor poisonous. Upon heating yellow sulphur to boiling and pouring it in water it becomes a red, soft, gummy substance, not unsimilar to rubber; upon exposure to the air it gradually goes back to the yellow variety. This property of retaining an abnormal state by sudden cooling has an analogous example in steel. If metallic tin is held at a temperature considerably below freezing for a long time it changes to a gray powder. When ordinary iron is heated to 1,420 degrees it changes into a non-magnetic variety, and at 1,650 degrees another change takes place. These three different varieties of iron are known as alpha, beta and gamma, and sufficiently rapid quenching from the right temperatures is capable of retaining the beta and gamma form more or less perfectly at the ordinary temperatures. It is thus very apparent that while steel is an alloy composed of two constituents, it can really be considered as being capable of forming three distinct series of alloys, namely carbide of iron with alpha, beta and gamma iron. There is considerable difference of opinion regarding the occurrence of beta iron.

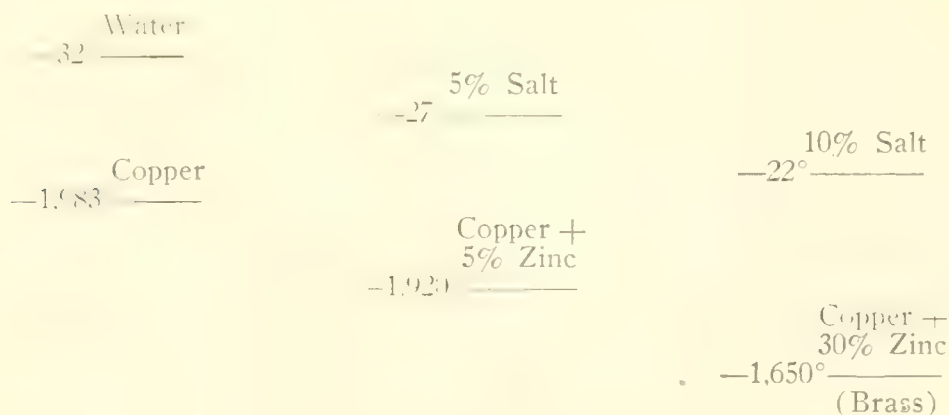


FIG. 3.

The critical temperatures of a substance are usually changed by the addition of another substance. This is shown by examples in Fig. 3. Pure water freezes at 32 degrees; this temperature is

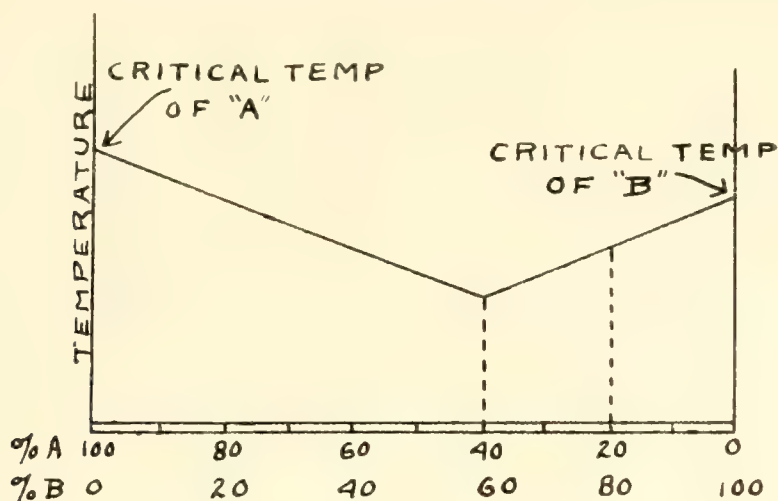


FIG. 4.

lowered to 27 degrees by the addition of 5 per cent of common salt and to 22 degrees by the addition of 10 per cent of salt. Molten copper begins solidifying at a temperature of 1,983 degrees; this temperature is lowered to 1,920 degrees by the addi-

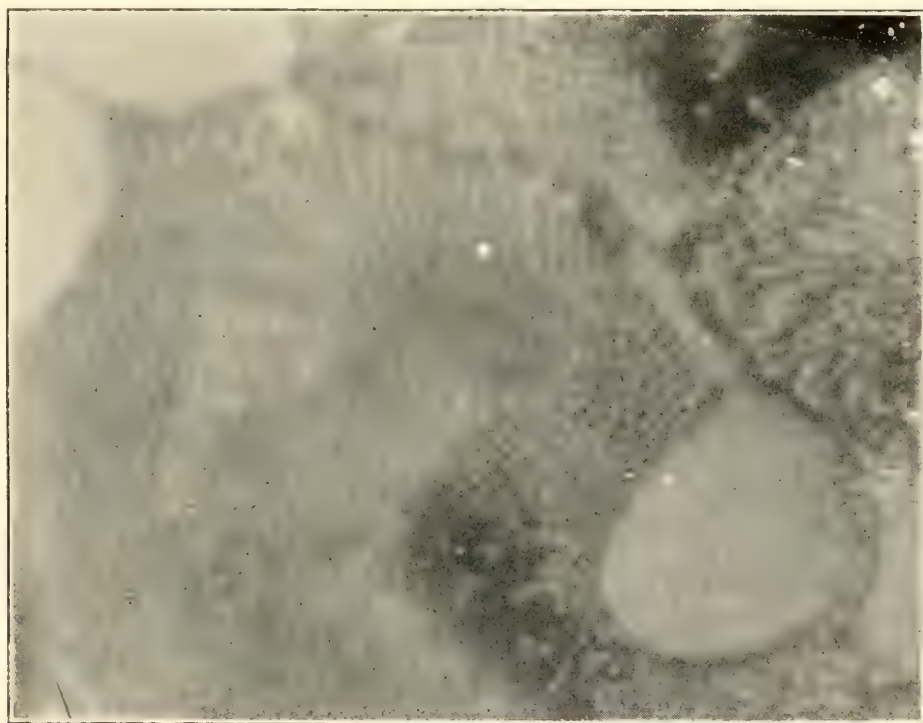


FIG. 5.

tion of 5 per cent of zinc, and to 1,650 degrees by the addition of 30 per cent of zinc, which is common brass.

Consider an alloy of two components, *A* and *B*. If the addition of *B* to *A* causes a lowering of the critical temperature of *A*,



FIG. 6.



FIG. 7.

it is reasonable to suppose that the addition of A to B will cause a lowering of its critical temperature. (There are some classes of alloys in which this is not so.) Under these conditions it is apparent that there must be some alloy of the series which would have a lower critical temperature than any other. Fig. 4. In alloys in which this critical point represents a change in state, this



FIG. 8.



FIG. 9.

one of the series is known as the *eutectic*. In steel which exhibits a similar phenomenon not accompanied by a change in state it is known as the *eutectoid*. In our example we will consider that the eutectic ratio is 40 of *A* to 60 of *B*. Suppose we have 20 of *A* and 80 of *B*, we might consider this 20 of *A* to be combined with

30 of B to form an eutectic, leaving 50 of B not so associated. This is exactly what does occur, and we might consider such an alloy to be composed of an eutectic and either A or B . Figs. 5 and 6 show photographs of two different alloys, each composed of an eutectic and an excess substance. Fig. 7 shows the eutectoid of steel made up $13\frac{1}{2}$ parts of Fe_3C and $86\frac{1}{2}$ parts of iron. This photograph shows also an excess substance consisting of Fe_3C in the form of a net-work of white material.

The eutectic ratio for steel ($13\frac{1}{2}$ Fe_3C to $86\frac{1}{2}$ Fe) corresponds to a carbon contents of approximately 0.90 per cent. This explains the reason for the importance of slight changes in the carbon contents for a 1 per cent carbon steel, instead of consisting of 1 per cent carbon and 99 per cent iron, really consists of 15 per cent carbide of iron and 85 per cent iron.

Fig. 8 shows the position of the critical points for the entire iron carbide of iron series.

When the temperature of a piece of steel is raised above the critical temperature at which gamma iron is formed, we have an alloy formed of gamma iron and carbide of iron. The eutectoid no longer exists in this series, but in its place is a homogeneous solution, which goes by the name of austenite, a transition form of which is martensite. This can be retained, to a greater or less extent, by sudden cooling or quenching and is an important constituent of all heat-treated steels at some point in the process of their treatment. One variety of martensite is shown in Fig. 9. It is characterized by a needle-like arrangement, parallel to the three directions of an equilateral triangle.

There are many intermediate stages between the series of alloys containing martensite and the series made up of alpha iron and carbide of iron, which is the series containing the annealed steels.

Broadly speaking, heat treatment consists of obtaining different physical properties in the same steel by varying the relative amounts of the different series of alloys present.

This may be done in several ways; usually the steel belongs originally to the series containing the alpha iron. A definite amount of this can be changed to the gamma or martensite series, or all may be changed to this series and then part brought back. Combinations of these two methods are also used. With the same final per cent-composition of the two series, the physical properties will be entirely different depending upon the method by which produced.

Since the temperature of the critical points is of extreme importance in heat-treating, it is evident that we must be able to measure high temperatures with a considerable degree of accuracy. For this purposes *pyrometers* are employed. There are four general types of pyrometers—thermocouple, resistance, radiation and optical. The most widely used is the thermocouple type.

Thermocouple:—In general, if two dissimilar metals are placed in contact, there is created a difference in electrical potential at the other ends; this difference is a function of the

temperature of the ends in contact so that if a milli-voltmeter be standardized to read in temperature degrees instead of milli-volts it can be used for temperature measurements.

Resistance type:—The resistance of a platinum wire increases with the temperature; therefore, if the resistance be determined

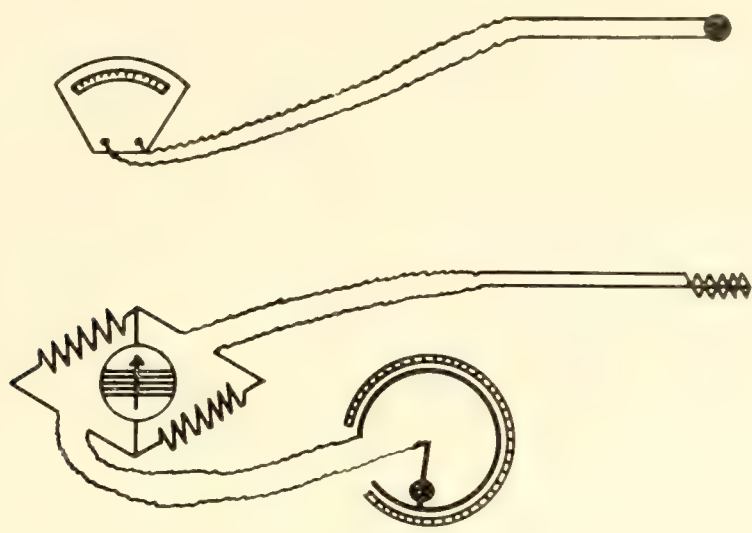


FIG. 10.

for different temperatures by means of a Wheatstone bridge or a Kelvin balance, this balance could then be graduated to read temperature instead of resistance. Fig. 10 gives the principle of the thermocouple and resistance pyrometers.

The radiation type consists of a thermocouple type, in which the thermocouple is not placed in the furnace, but a certain amount of radiant energy is focused from the furnace upon it.

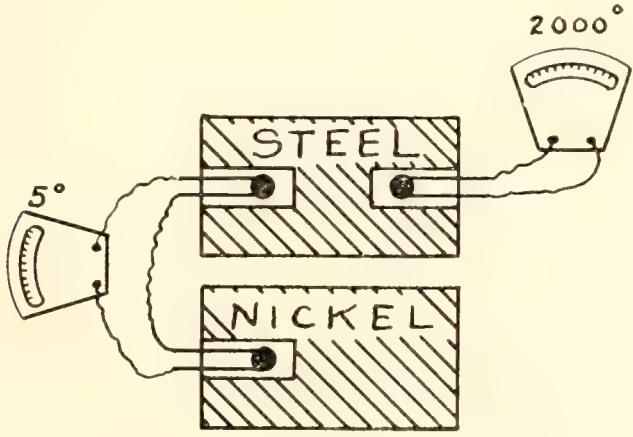


FIG. 11.

The optical type compares the amount or color of light given by the body or furnace with a standard light or color.

Methods of obtaining critical points:—The critical points are obtained in various ways. The most common and least valuable method, as far as heat-treating is concerned, consists in finding the jog in the heating or cooling curve by means of an ordinary thermocouple and plotting the temperature against the time, as

shown in Fig. 1. This method usually fails entirely to get the critical point in low carbon steels which are the most important from a heat-treating standpoint. The *magnetic critical point* can be obtained, more or less roughly, by means of a common magnet and a pyrometer. It is of very little value for the low carbon steels as this critical point is not the one used for general heat-treating. An extremely accurate method of detecting critical points in low carbon steels is shown diagrammatically in Fig. 11. A neutral body having no critical points, such as nickel, is placed in the furnace side by side with the steel. The thermocouples are connected, as shown. In series with two of the couples is placed



FIG. 12.

a very sensitive galvanometer having a full scale deflection equal to about 5 degrees, while the third couple is connected to a regular pyrometer galvanometer or milli-voltmeter with a deflection equal to about 2,000 degrees. This is to determine the temperature at which the critical point occurs. As the temperature of the steel rises, the temperature of the nickel rises with it and consequently, if not heated too fast, they will both be at the same temperature at any given time and the voltage generated by the couple in the nickel will neutralize that generated by the couple in the steel and as a result no current will flow. However, when a critical point in the steel is reached, its temperature will momentarily lag behind that of the nickel with a resultant flow of current through the

sensitive galvanometer. The temperature at which this occurs is then read off on the other instrument. Means are usually provided for making a photographic record of the position of the critical points. This is known as the differential pyrometer method.

The most accurate method of obtaining critical points is by means of the microscope. This requires an extremely accurate pyrometer and a thorough knowledge of the theoretical constitution of steel. In connection with this a potentiometer allows the most extreme accuracy. This instrument is for measuring the voltage generated by thermocouples to about $1/10,000,000$ of a volt. It is new for this purpose and is not in general use.

We will now consider some of the effects of heat-treatment. The elastic limit of a piece of steel is a measure of its value in sustaining a dead load constantly.

The maximum strength is a measure of its ability to withstand a load in excess of its elastic limit.

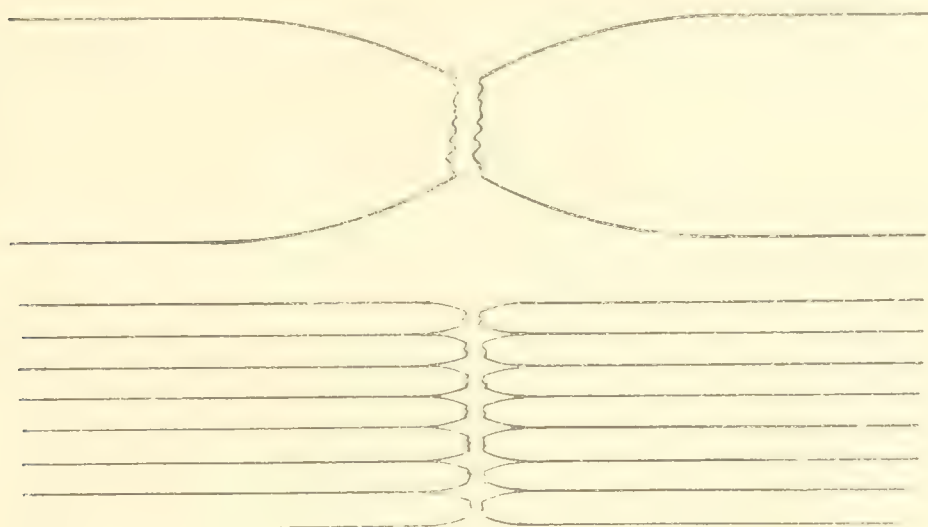


FIG. 13.

The reduction in area is a measure of its ability to withstand shocks (other things being equal) and also of its ability to bend without fracturing. In common language, it is considered as a measure of the "toughness" of the steel.

The elongation is quite frequently used as a measure of properties similar to that given for reduction in area. This is not as accurate as the reduction in area.

A measure of the ability of the steel to withstand recurring shocks and strains is best obtained for practical purposes by a combination of the above physical properties considered together with the chemical composition, and then by the physical condition of the steel, as shown under the microscope.

Fig. 12 is an illustration of the same steel treated in two different ways to bring out entirely different properties. In one case the steel has been heat-treated to withstand high static stresses, while in the other it has been treated to withstand high dynamic stresses.

Fig. 13 illustrates why the reduction in area is a better measure of the toughness of the steel than the elongation. We have here considered one steel to be full of longitudinal fractures. If the two steels were treated in the same manner, the elongation

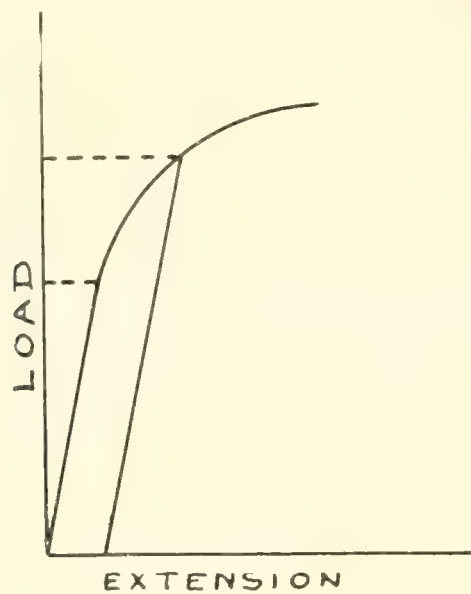


FIG. 14.

would be practically the same for each, and if this were taken as a measure it would not bring out the fatal defect in the steel, which would be readily detected if the reduction were taken as the measure.

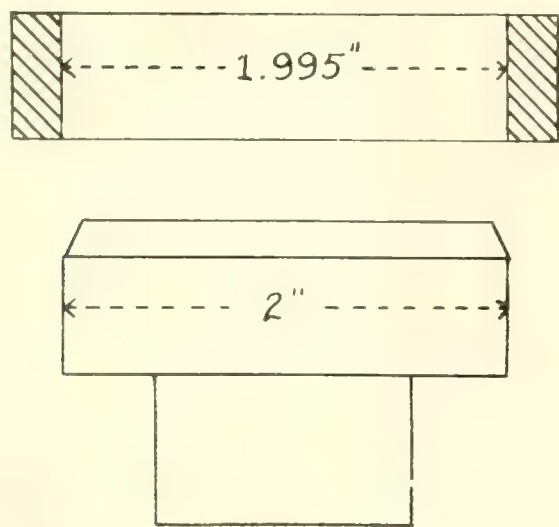


FIG. 15.

Fig. 14 illustrates a curve plotted during the breaking of a test piece. As the load increases the extension or stretch increases at a constant rate until the elastic limit is reached, when the extension increases at a far more rapid rate compared with a cor-

responding increase in load. Now if some time after the elastic limit has been reached the load is released and then again applied, the new apparent elastic limit will be at the point where the load was formerly released. In other words, we have made an apparent increase in the elastic limit. A brief consideration of this will show that the true elastic limit of a piece of steel cannot be obtained accurately after the steel has been strained beyond its elastic limit at some previous time.

The specific gravity of a piece of heat-treated steel is lower than before treatment. This is equivalent to saying that heat treatment causes an expansion in the steel. Depending upon the shape of the piece this expansion may take place entirely in one direction and cause an apparent contraction in the other.

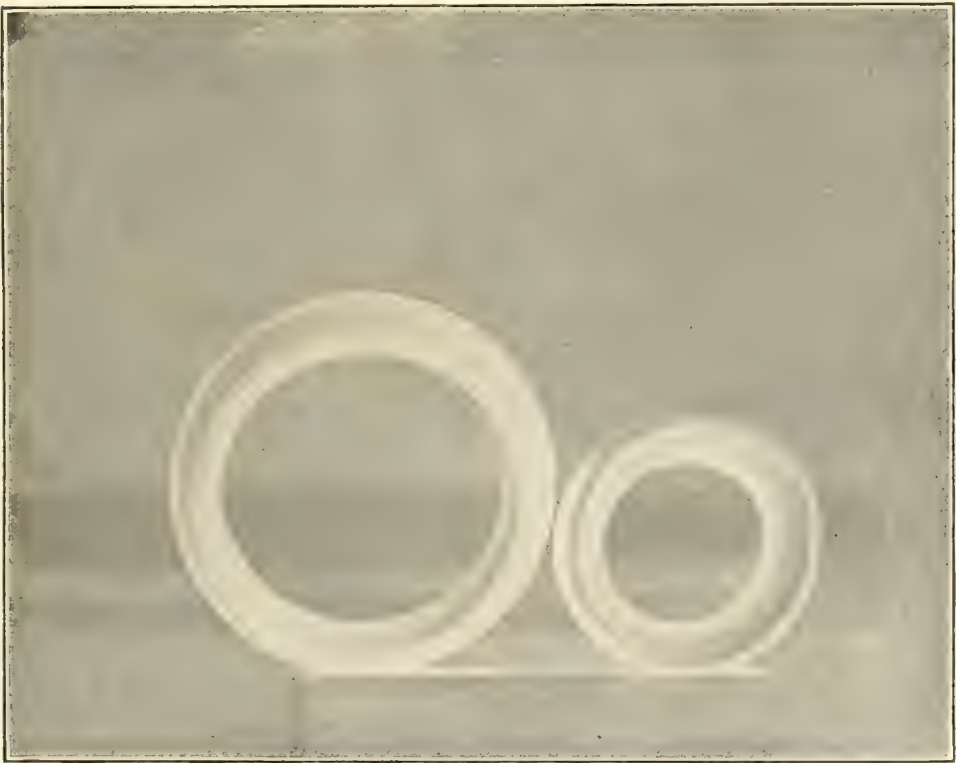


FIG. 16.

The amount of this expansion is dependent, to a great extent, upon the chemical composition. Fig. 15 illustrates a method of demonstrating this expansion. If a steel ring be made of smaller diameter than a plug, and the ring be heated above the critical range and placed over the plug and then quenched in water, the ring can be easily removed from the plug. However, if it be allowed to cool slowly on the plug, it will be almost impossible to remove it.

By repeated heat treatments of a certain kind steel can be caused to shrink. Fig. 16 illustrates two rings, both of which were originally of the same size.

Fig. 17 illustrates a piece of steel, $\frac{1}{2}$ inch in diameter, which has been carbonized until the depth of carbonization is a little



FIG. 17.



FIG. 18.

less than $1/16$ inch. In this case the carbon contents of the outer rim is about 1.25 per cent, while that of the core is 0.20 per cent. This sample has been heat-treated with three different purposes in view: First, to make a tough and strong core; second, to



FIG. 19.



FIG. 20.

make a tough rim, which will not chip, and third, to make a hard surface.

Figs. 18 and 19 show the same gear case hardened in a way similar to Fig. 17. In Fig. 18 the gear has simply been hardened,



FIG. 21.

while in Fig. 19 it has been heat-treated as well as hardened. In the first case it took 16,000 pounds to cause a fracture of the tooth, while in the second case it required 30,000. In addition to this, the gear in the first case was very brittle and would break

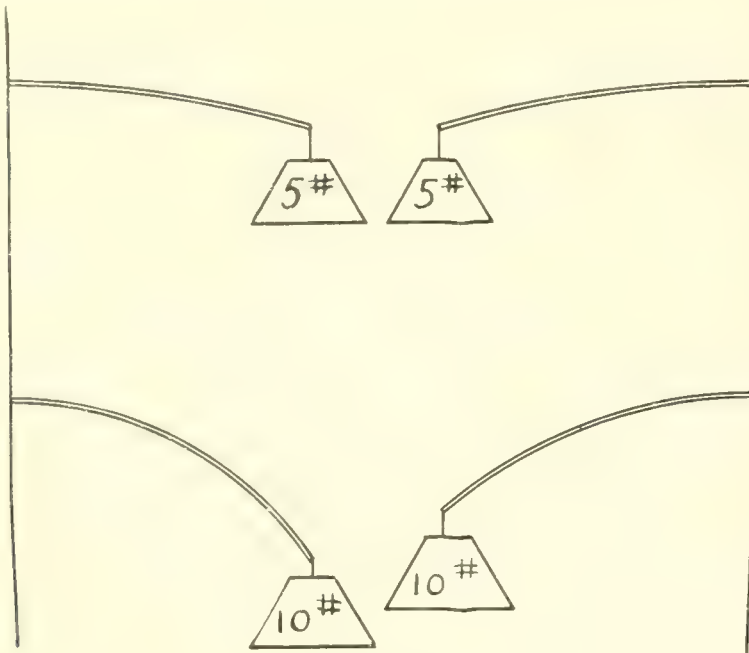


FIG. 22.

with a few comparatively light shocks, while in the second case the gear would resist almost indefinitely the same shock.

Figs. 20 and 21 show microphotos of the surface of these

same two gears. In Fig. 20 the cause of the brittleness of the gear is seen to be the large sheets of carbide of iron, while in Fig. 21 this has been almost entirely disseminated into invisible particles.

The stiffness of a piece of steel cannot be increased by alloying nor by heat treatment. By this I mean that provided the elastic limit is not exceeded, the amount of deflection for a given load cannot be decreased. However, heat treatment will raise the elastic limit so that a much greater load can be carried without causing a permanent set. Fig. 22 illustrated this. The steel to the right has been heat-treated so that in the lower figure its elastic limit has not been reached, while under the same conditions the steel to the left which is not treated has passed the elastic limit with the 10-pound load. All steels, no matter how treated or of what nature, will deflect the same amount under the same load. However, the poorer grade steel or the unheat-treated one will reach its elastic limit first and will then deflect much more and retain a permanent set.

Grade.	Carb.	Treat.	Strength.	Red.	
Plain	0.20	No	52,000	60%	(100) Nickel
Plain	0.45	No	65,000	45%	1%, 3½%, 5%, 7%, 35%
Plain	0.20	Yes	75,000	60%	(50) Chrome-Nickel
Plain	0.45	Yes	110,000	3%	1½-3½, 1-1½, ½-3, ½-1
Alloy	0.20	No	76,000	60%	(25) Chrome
Alloy	0.20	Yes	135,000	60%	(10) Chrome-Vanadium
Alloy	0.35	No	110,000	55%	Silico-Manganese
Alloy	0.35	Yes	280,000	25%	(300) Titanium
					Tungsten (Molybdenum)

FIG. 24

FIG. 23

When certain alloying elements are added to steel, remarkable results are produced. With the same degree of toughness the strength can be enormously increased and with the same degree of strength the toughness can be likewise increased. These alloy steels show up their remarkable properties to a greater extent when they are heat-treated. Fig. 23 gives some of the commercial alloy steels now in common use. Fig. 24 gives a comparison among plain and alloy steels both heat-treated and unheat-treated. For the sake of comparison the treatments were designed to give the same degree of toughness in most cases and in this way the strengths could be compared.

A plain and alloy steel of the same carbon contents was selected. Compare this 0.20 per cent carbon steel, both plain and alloyed. With the same reduction in area, namely 60 per cent, the plain steel untreated has a strength of 52,000 pounds. This can be increased to 75,000 by treatment and at the same time this treatment adds enormously to the resistance to alternate and recurring stresses. Now by taking this same steel and adding an alloy to it we can get 76,000 strength, which is practically the same strength as the plain steel heat-treated. We can here bring out a very important fact. Immense quantities of alloy steels are used in an unheat-treated condition. This alloy steel is several times as expensive as the plain steel, and yet we could

get the same properties from the plain steel by the proper treatment. Now compare this same alloy steel when treated; we see that we can get 135,000 strength with no diminution in toughness.

If we endeavor to increase the physical properties by means of increasing the carbon contents we find that it can be done only imperfectly and at a large decrease in the reduction in area or toughness. Compare the 0.45 per cent plain steel with the 0.20 per cent carbon alloy steel, both unheat-treated. Now compare the effect of increasing the carbon on the alloy steel to 0.35 per cent. With this steel we can raise the strength to 280,000 with a fair degree of toughness, while the higher 0.45 per cent carbon steel can be raised to 110,000 pounds with practically no toughness.

The tremendous importance of heat-treating all kinds of steels is recognized on all sides. It not only means a saving in money, but a saving in weight as well as to produce steel which will be far superior to resist fatigue. Steel rails as well as splice bars for joining rails are now being heat-treated. No one can doubt that the future will be an age of heat-treated steels both in the plain and alloyed form.

Discussion

MR. MELENDY: —

In the treatment of sulphur, where yellow sulphur is converted into red sulphur, it is known that if red sulphur is allowed to stand for any length of time it gradually resumes the yellow form.

MR. ABBOTT: —

Steel, when changed into the series containing gamma iron, will probably go back into alpha iron at an extremely slow rate at ordinary temperatures. This is not a demonstrated fact, excepting in one case. We find hardened steel implements in the pyramids of Egypt, and they are still hard today, which shows that we have gamma iron—that in this long item it has not changed noticeably at normal temperatures. After steel is magnetized, upon letting it stand for a long time the magnetic properties are lost; that shows that the gamma and Beta condition of the iron does return to the alpha condition.

MR. TYLER: —

From the paper read the question occurs to my mind, can that accuracy be carried out in the workshop; and if so, can it be carried on with sufficient accuracy so that the engineer will feel perfectly secure in doing this?

MR. ABBOTT: —

It certainly can. The great trouble has been in convincing the engineer. In other words, the engineer has been a little doubtful; likewise there has been a great deal of trouble in obtaining steel sufficiently accurate to a given specification so that in a commercial process every piece will have approximately the same physical properties. Now, if you are not sure of your chemical proposition, you certainly do not know what to do so far as your heat treating is concerned—you must have a definite carbon range. With ordinary care, the hardening room can be run with sufficient degree of accuracy to obtain wonderful results. That was not so five years ago; it is so at the present time.

MR. ROBERTS: —

I would like to ask for a statement regarding relation of heat treatment to the size of the pieces of steel treated.

MR. ABBOTT: —

I was going to bring that out in the discussion tonight, but did not do so for this reason: There are two gentlemen of Case School of Applied Science, who are working on that problem in our laboratory, and I thought I would not say anything about it until they give us the results they obtain.

They are working along the following lines: Starting with a very uniform bar of steel, about 4 inches in diameter, and then

turning this down in $\frac{1}{4}$ -inch steps and treating with reference to the critical points, they have obtained curves showing the decrease in strength, due to the increase in size. They have found some very remarkable results, such as that alloy steel acted entirely different from plain steel. I really cannot give you any information regarding the actual value obtained.

MR. TEXTOR:—

How low can the carbon be, or will the treatment affect very low carbon?

MR. ABBOTT:—

Any steel can be affected; I have obtained on pure iron hardness in gamma iron practically double the hardness of alpha iron; I have obtained 15 to 20 per cent increase of strength on practically pure iron. The statement is generally made that steel will not respond readily to treatment below 20 points of carbon, we are getting good results from below 20 points of carbon and doing it commercially.

MR. HARMON:—

When we take two pieces of steel and weld them together, will it be as strong?

MR. ABBOTT:—

If it is done correctly, it can be made as strong. We made such a test with electrically welded pieces and upon breaking them, nine times out of ten they fractured away from the weld; when they do break at the weld, it is due to the composition of the material or to the poor weld; but when properly done, it is equally as strong in tension as the part not welded.

MR. W. H. ABBOTT:

I would like to ask if there is any difference from results obtained from electric welding or ordinary welding, whether there is any difficulty in getting the same results from such a weld as ordinary weld when heat treated.

MR. ABBOTT:—

I have never found any difference. A piece of steel welded by electricity usually shows more sudden changes in physical properties along its length either side of the weld. The change between the hot part and the cold part takes place in a very short space, much more so than the ordinary weld. Proper heat treatment eliminates this. If the weld is treated properly, I have never found any difference.

MR. HIMES:—

My experience leads me to believe that the uncertainties concerning the product to be used in the construction of a bridge—if treated by heat in order to increase its strength—would be such as to make it very doubtful whether all members of the

bridge would be uniform in quality so as to work together in harmony and develop the unit stresses for which they were designed.

If it could be shown that steel could be so treated in sufficient quantity and that its quality would be as uniform as the quality of the steel now used, then we might enjoy this economy; but I think some very conclusive testimony must first be presented to convince bridge engineers that it would be safe to rely on heat-treated steel to safely carry a unit stress much greater than that now commonly used.

MR. ABBOTT:—

The question of uniformity of heat-treated steel has been brought up with a great deal of justification; there are not many places, or have not, up to the last year, been places which had the equipment or the knowledge, so that they could get a perfectly uniform product. That is rapidly passing away, and at the present time the big steel-makers are turning their attention to this product. Within the last few years many of the largest steel-makers in America have been working on this problem. At least two of them are working on heat-treated rails. Not only wearing qualities, but the danger of breakage, due to constant shock, is enormously reduced in heat-treated steel. The hardness might be doubled—the resistance to shock, and continued stresses might be raised one hundred fold. For this reason heat-treated structural steel is going to come into common use; and, I believe, in a very short time.

MR. WASHBURN:—

Does heat treatment affect all kinds of steel in the same way?

MR. ABBOTT:—

Some of the bad effects which have been obtained in attempting heat-treating in various places are easily explained. The composition of the steel has a very decided effect upon critical temperatures, and the presence of alloying elements particularly influences these temperatures very markedly, and unless we know just what effect a certain per cent composition has, we are going to get into trouble by using the wrong heat treatment for a certain steel. The heat treatment must suit the composition of the steel and must be changed to conform to changes in it.

MR. IRWIN:—

I would like to ask Mr. Abbott, in connection with determining the critical points of steel, between what limits of carbon content is the magnet effective in determining those points?

MR. ABBOTT:—

The magnet will detect the middle critical point in steels below 0.40 per cent carbon and the upper critical point from 0.40 to 0.90 per cent and the lower one above 0.90 per cent. This is

modified, to a considerable extent, by the amount and nature of the other elements present.

MR. MENDENHALL:—

I would like to inquire what is the relative elastic limits of the plain steel and the alloy steel as described, a comparison in regard to their work in bridge construction—the elastic limits govern—I don't remember if that point was clearly brought out.

MR. ABBOTT:—

I could not get together a series which would illustrate the points I wished to emphasize in which elastic limits were used. I used the maximum strength. Heat-treated steel almost always has the elastic limit nearer the maximum strength than the unheat-treated. The elastic limits may be raised to coincide with the maximum strength by heat-treating many steels.

MR. TEXTOR:—

Are we to understand that the proper heat-treating of steel composed of iron and carbide of iron is to be used to replace all alloys?

MR. ABBOTT:—

No. Unheat-treated alloy steel could be replaced by a heat-treated unalloyed steel. I brought this out because there are large quantities of alloy steel which are not heat-treated; they are an expense and could be replaced by plain heat-treated steels.

MR. W. H. ABBOTT:—

Will Mr. Abbott give us an idea of the cost of heat-treating, for instance for automobile purposes; a price per ton for small pieces and for large pieces?

MR. ABBOTT:—

I have a very complete cost data on one particular part of an automobile, and at present I am obtaining cost data on all parts of automobiles, but I am not prepared now to give it. It will run from $\frac{1}{4}$ c per pound to 5c per pound. That is as close as I can give it now.

MR. W. H. ABBOTT:—

It depends upon the size, or the treatment?

MR. ABBOTT:—

It depends both upon the size and treatment. We get the higher cost on treatment that requires more accuracy, due to increased cost in the up-keep of the furnace, more expensive pyrometer installation, etc. There are so many things entering into it, it is hard to give accurate cost in general. The larger the piece of material the less the cost per pound.

MR. WEST:—

Was that 300 on titanium steel—alloy steel?

MR. ABBOTT:—

Yes. Titanium steel is really not what we call an alloy steel; actually it is, but we do not consider it so—it does not give the physical properties that nickel and chrome and elements added in larger amounts do. It is used largely as a purifying agent.

MR. TEXTOR:—

I would like to ask if you have any data regarding the cost of introducing certain effects; for instance, in order to increase the elastic limit to a definite percentage with certain given cost, which element would give the effect the cheapest—have you any data on that?

MR. ABBOTT:—

No, I do not believe it could be obtained very readily, because the cost of steel of the same composition, of two different makers, would be so different; one would make it with less care—they might show different physical properties. If you got the various alloy steels from the same maker, you might calculate this fairly well; but that would not be commercial, because you would want to buy your steel on the open market and it would be a hard thing to determine.

MR. LINDERS:—

Steel casting, how is that affected by heat-treatment?

MR. ABBOTT:—

Usually steel castings do not respond very uniformly to heat-treatment other than to the ordinary annealing, due to irregularities in the material.

MR. LINDERS:—

I would like to ask about distortion where the sections are not uniform.

MR. ABBOTT:—

There is a great deal of distortion on irregular section—that is up to the practical man in the shop to take care of. I know of extreme cases, where it cannot be done. You don't run across that very often.

MR. ROBERTS:—

Relative to the two rings, showing the diminishing size, what was the effect on density?

MR. ABBOTT:—

The density is about the same; at the time I made this experiment, I started with eight and shrunk four. Chemically, the steel was practically the same as it was originally; the microscopic structure was a little different.

MR. W. H. RUPPEL:

I would like to ask if there is no easy method of determining when the result has been obtained. Suppose a piece has been heat-treated, and one wants to know whether he has arrived at his results, what is the easiest method, or rather is there any easy method of determining whether or not you have given it the proper treatment—is it microscopic, photograph, analysis, or is there any method of telling?

MR. ABBOTT:—

The right way to do is to be sure of your chemical analysis and heat-treatment; then you will get uniform results. For testing there are various ways; one of the best ways of testing the treatment is by the physical properties of hardness.

We can get a rough idea of the physical elastic limits by its hardness. The other is by the microscope; if you polish a piece, you can determine whether it has been properly treated or not.

MR. ROBERTS:—

Mr. Abbott, I would like to know how you took the measurements of those rings.

MR. ABBOTT:—

When I was experimenting on that ring, I made a sensitive instrument that scaled to 1/10,000 inch. After every treatment I measured the inside and outside diameter, and the height of the ring. I found I got a very uniform curve; as the metal got smaller, the size changed more rapidly than when it was larger, the width of the ring increased, and the outside diameter decreased not as rapidly as the inside. The inside decreased most rapidly.

MR. WEST:—

I would like to ask Mr. Abbott where he got the data on titanium steels.

MR. ABBOTT:—

That was published in the statistics of the American and foreign iron trades by the American Iron and Steel Association.

MR. WEST:—

Does titanium act the same as vanadium?

MR. ABBOTT:

Titanium is very similar in some of its action to vanadium in that it is used as a purifying agent.

MR. WEST:—

Is it true that the maker can use titanium in his furnace and the laboratory find no trace of it?

MR. ABBOTT:—

That is true.

MR. WEST:—

Then how can you tell whether there was titanium in the metal?

MR. ABBOTT:—

You cannot tell.

MR. WEST:—

Then you would not know whether titanium was used in it or not?

MR. ABBOTT:—

I have several samples of titanium steel, in which there is titanium present. I find there is a difference required in heat-treatment when titanium is present.

MR. WEST:—

What percentage did you give for vanadium steel used?

MR. ABBOTT:—

Do you mean the relative amount compared to titanium?

MR. WEST:—

Yes.

MR. ABBOTT:—

Ten to three hundred.

MR. WEST:—

Straight vanadium steel?

MR. ABBOTT:—

I have no data on the amount of straight vanadium steel.

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Society Notes

ANNUAL OUTING

A very profitable and enjoyable outing was the inspection trip to Ashtabula on the U. S. S. Dorothea, Saturday, July 20. A written account by its very nature fails to convey adequately an appreciation of the social and fraternal spirit in evidence from the time the dock was cleared in the morning until the return at 11:30 p. m.

As soon as the ship was well under way outside the break-water, the party made a tour of the boat during which the vessel's equipment was inspected. Commander Bolton was asked to tell us about the Naval Militia, whose hospitality through his courtesy we were enjoying en route.

Address of Commander T. B. Bolton.

Mr. President and members of the Cleveland Engineering Society:

I am not much of a speech-maker and, when Mr. Gachr asked me to make a few remarks, I rather demurred, but he suggested that you would want to know something about the Naval Militia, and I am always ready to talk on that subject.

One of the greatest things we have to contend with is the complete lack of knowledge and interest on the part of the average American citizen in regard to all things naval and military. He is too busy making money or following the pursuits of happiness to devote any time to the development of his patriotic side. This is not to say that the American citizen is unpatriotic, but to point out that there are too many counter attractions, too many side issues, to allow of his giving any of his valuable time to his government.

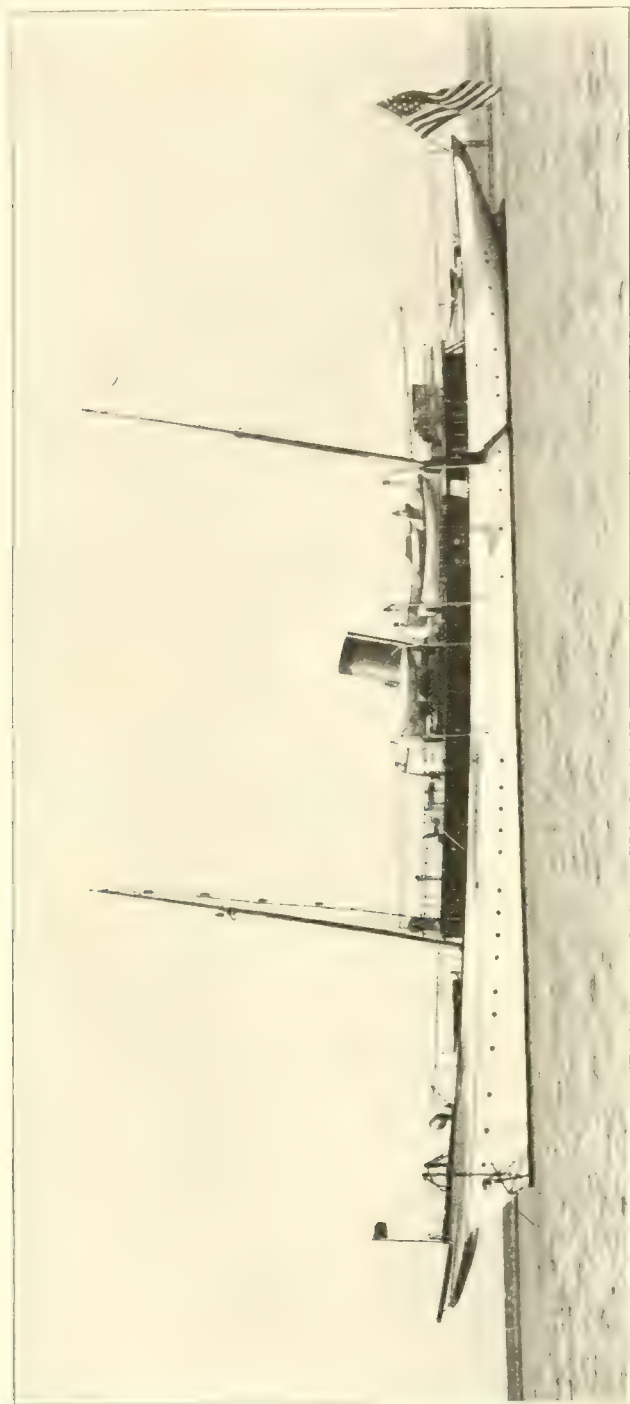
The Naval Militia was organized in Cleveland, I think, as far back as 1896, and yet even today I am met with the question, What are the Naval Reserves? So, I say, it is one of the very discouraging features to observe this lack of knowledge and interest in militia affairs on the part of the people in general. But, while the people are not interested, the government is.

Every year Congress appropriates \$125,000, which is divided among the various states according to their numerical strength and that amount is placed to our credit in the different bureaus and supply yards, upon which we may draw for various supplies and articles needed. Printed matter and books of instruction are sent around for our use, and once each year the different organizations are assembled for about two weeks practice aboard ships. On the coast many of the organizations are taken aboard the battleships, while we, on the lakes, are assembled on the ships in fleet and are put through all the exercises practiced in the navy.

The object of the organization is to form a Naval Reserve. There are about 8,000 enlisted men and about 700 officers in the

various naval militia organizations, scattered among 28 states, all of which are either on the seaboards or on the great lakes, except one, Missouri, which has an organization at St. Louis.

The Navy department now has 16 first class battleships laid up at the various navy yards on the Atlantic and Pacific coasts, in what they call "In Commission in Reserve". That is, they have



U. S. S. DOROTHEA.

on board skeleton crews of just enough men to keep them in first class condition. They lie there fully provisioned, coaled, with a complete supply of ammunition aboard, and ready to go to sea at a moment's notice. All they need is the men, and it is estimated, by gathering up the naval militia organizations and sending them aboard, each ship could be made a valuable fighting unit within 48 hours after the call. We are engaged in preparing

for such an emergency. To meet it in the manner outlined is much cheaper than to keep the ships in full commission continuously.

I consider the work very important. It is probable that in the next great war—that is in hostilities with any one of the great powers—the first clash will come on the waters. The enemy will send out its battle fleets to clear the way, and the nation which can present the strongest battle line will thereby gain an immense advantage over its opponent, if not actually decide the war right there. We want every one of our fighting ships in that battle and it can't be done if their crews have to be recruited from civil life. This is the object of the Naval Militia and we are training the men for this very purpose. There ought to be 25,000 instead of 8,000 men.

Now as to the plan of organization. Right now each state has its own plan. We are not directly responsible to the Navy department, but are subject to the orders of the Governor of Ohio. There is a bill pending in Congress which, if passed, will bring us into the same relation to the Navy department as the National Guard is to the Army. In this state we are organized under a special act of the Legislature, which permits two ship's companies to be known by the ship assigned. Therefore, this organization is the U. S. S. Dorothea Ship's Company, Ohio Naval Militia. The state appropriates a certain amount each year for our use in the upkeep of the ship and for pay of the crew. We keep eight men on the ship during the active months of the summer. These men devote their entire time and, of course, have to be paid; their wages, however, are very small, from \$30 to \$45 a month, and most of them come down because they like the work and can afford to do it. The officers and men generally draw no pay except when on ordered duty such as the annual cruise, riot duty, etc.

There are nine ships on the lakes, making quite a fleet in all, any ship of which would have been able to cope successfully with the combined American and British fleets at the battle of Lake Erie.

This organization was mustered into the service in 1896 and has been on the map ever since. At first it was nothing more than land militia, but in 1901 the Hawk was brought around from salt water. The Dorothea was brought around by the Chicago reserves in 1902 and in 1909, that organization having outgrown it, the U. S. S. Nashville was loaned to them, and we received the Dorothea.

The Dorothea was built in 1898 at Cramp's Ship Yards, Philadelphia, for Mr. Drexel of that city, but was bought by the federal government, while still on the ways, and launched after some interior alterations were made to adapt it for the service intended. She was put in commission as a torpedo destroyer and dispatch boat and saw service around Cuba. She is 210 feet long, about 585 tons displacement, develops approximately 1,500 horsepower and is today one of the finest ships on the lakes.

This is all I can think of at this time as being of special interest, but I wish to express our pleasure at having you aboard

today and trust we may later have the satisfaction of having you with us.

As we neared Ashtabula, Mr. Rockwell explained the layout of the harbor and described the various improvements.

Mr. Rockwell's Address.

It is a pleasure for me to be present on this occasion and to speak to you of the new docks and machinery which the Lake Shore Railway has constructed at Ashtabula for the purpose of handling and storing iron ore.

There are two plants for handling ore at Ashtabula. The Pennsylvania Lines are located upon the west side of the river and the Lake Shore on the east side. Both companies had their plants originally in the inner harbor, but the need of more room for the increasing business and the rapidly increasing size of boats made it necessary to build additions on the lake front, while the rapid development of ore and coal handling machinery, which has made obsolete plants built within only a very few years, and the great capacity of the most recent plants, will undoubtedly cause all the ore to now be handled by these new plants on the lake front.

The latest and largest of these plants is that built by the L. S. & M. S. Co. on both sides of the new slip east of the river mouth. There are four Hulett unloaders with 15-ton buckets on each side of this 250-foot wide slip, and each side has storage capacity for 1,000,000 and 900,000 tons, respectively, of ore served by a Hoover and Mason bridge, 623 feet long, with 15-ton bucket conveyor. This machinery constitutes the highest development of the art of handling ore up to the present time, and it is difficult to see what more can be needed. Each of these eight Hulett unloaders will handle from start to finish of a boat an average of 500 tons of ore from boat to cars or dock per hour, or the four machines in battery on each side of slip will unload a 10,000-ton boat complete in five hours, or the slip has a capacity so far as machinery is concerned for unloading 80,000 tons of ore in two 10-hour shifts per day, which should hold the demand for a while. I have given the capacity of these machines conservatively at 500 tons per hour. They will easily handle 650 tons per hour in good digging, that is for the bulk of the cargo, the cleaning up, however, pulls the average down.

The new machines of the Pennsylvania Lines at Cleveland are of same design as the L. S. & M. S. machines at Ashtabula. They have 17-ton buckets, to be sure, but I am assured that the additional two tons each was given them only to bring their capacity up to that of the L. S. & M. S. machines, since the Pennsylvania have a higher lift. All these machines are operated by electricity, which for these L. S. & M. S. machines is generated at a Central Station on each dock. These stations were built separately because the plant on the west side of the slip was built first and by the United States Steel Corporation. That on the east side of the slip was built a year later. Both are now owned, however, by the L. S. & M. S. Ry. Co.

The inner breakwater east of the harbor mouth was extended by the L. S. & M. S. Ry. Co. past the new docks and slip,

it being at that time the only protection from the lake. The U. S. Government is now building an outer breakwater and is, as you see, widening the entrance by dredging away from the west end of the old breakwater, but that portion of it in front of the L. S. & M. S. slip will remain as an inner protection to our plant.

The total investment in the new plant, including breakwater, slip, dock extensions and ore handling machinery on both sides of the slip, is about \$3,500,000, of which a little over \$2,000,000 represents cost of machinery for handling iron ore.

The work was started on slip, docks and breakwater in 1906.

Dock No. 1 went into operation September, 1909.

Dock No. 2 went into operation September, 1910.

All of the work was built under my direction as Chief Engineer.

I will be glad to answer any questions you may care to ask about it all.

We are now in Ashtabula and I am sure you will find it interesting to visit the layout on the Lake Shore tug, which is at your disposal. I am very glad to be with you on this occasion and shall take much pleasure in showing you about.

The party was taken from the Dorothea on the L. S. & M. S. tug to the new Lake Shore docks, where we inspected the plant just described by Mr. Rockwell.

While aboard the freighter J. C. Grammer, our attention was directed to temporary repairs in the nature of a cofferdam or bulkhead closing a great rent in her hull where she had been rammed and partly sunk with full cargo on her trip to Ashtabula. Divers, we learned, had built the bulkhead over the breach in order that the hold could be pumped out. She was floated and proceeded under her own power to unloading and dry docks.

In the dry dock of the Great Lakes Engineering Co. was a great steel ore carrier that had run over a sunken ship and stove her bottom for nearly her entire length, so that extensive repairs in replacing and straightening damaged plates were necessary. Several members of the party saw in this accident an occurrence similar in some respects to the Titanic disaster.

By the time the last plant, that of the Pennsylvania Company, was inspected, all were glad to board the Dorothea for the return trip. After supper the members assembled in the forward deck to listen to remarks by President Himes and several others.

Mr. Swasey referred with pleasure to the expression of Society spirit on the trip, and called it a noteworthy occasion when a body of engineers were guests on a government ship. He spoke of our flag with all its significance to the loyal American, illustrating by telling how his enthusiasm was aroused when he saw on his recent trip around the world that emblem of our country flying from a small vessel in foreign waters, after having long missed a glimpse of it from among the flags which were flying from the ships of many nations. He hoped for an extension of our foreign commerce and pointed out the value and necessity of a strong navy in preserving peace among the nations.

Mr. Geo. W. Bach told us many things of interest about the
naval militia. He said in part:

Address by Chief Engineer Geo. W. Bach.

Gentlemen:—

I feel highly honored, and it is a pleasure to have you on board our good ship *Dorothea*; I appreciate the honor, I assure you.

On the matter of making a speech, I want to say that our worthy and able Captain, who addressed you this morning, covered the Naval Militia subject thoroughly, except that he did not bring out the point that I thought of particular interest to Cleveland citizens. It is this:

The city of Cleveland was the first of the Lake cities to have a Naval Militia vessel. Many years ago, before the government allowed us ships for this purpose, the local Naval Militia men raised a fund and bought a ship, a steamboat, with their own money.

You can readily see that, by taking the initiative in this manner, Cleveland, the sixth city, ranks as a place of honor in Naval Militia affairs, as it does in other matters pertaining to civic progress.

This wonderful country of ours is ours, because the past generations were fighting men, men who had patriotism. That's what we want more of right now. Honor for the flag and not slandering of that good old flag and those who serve it.

None of the officers receive any money for this service, except when on the annual cruise, or in case of war or riot duty. We don't expect any remuneration. I am doing this because I realize the need of a body of trained young men. It was my privilege to serve the country during our late trouble in the Philippines, and I observed how the young men, who came out there for service on the ships, were next to useless for months, because they lacked the very fundamental training we are giving these young men.

This country needs a Military Reserve, fashioned after the Reserves of some of the European countries. In case of war we have not sufficient trained men to put into the field. This was clearly shown in our last war. More young men died because they could not take care of themselves on the food and water they got than were actually killed in action.

Gentlemen, allow me to thank you for your attention.

After the talks were over and the stories told, a most hearty vote of thanks was extended to all who had any part in making it a day of enjoyment on water and on shore. Everybody had a good time. Regret can come only to those who missed the pleasure of being on the trip. How fortunate it is that they do not realize the joys of lost opportunities.

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Railway Grade Crossing Elimination Viewed from the City's Standpoint

BY ROBERT HOFFMANN.

It is difficult to view the proposition outlined in the title of this paper from the city's standpoint alone. In dividing the cost of the work of eliminating railway grade crossings, the railway companies, under existing state laws, bear the greater proportion. It is therefore fair and just that due consideration be given to the interests of the railway companies, in so far as the operation of their business and their property is concerned. Any exhaustive treatment of this proposition should view the question from all standpoints.

In a former paper by the writer it was attempted to treat the subject of grade crossing elimination in general as it appeared in the light of several years' experience. In the following an effort is made to emphasize a few points wherein the city is specially interested.

In the consideration of elimination of railway grade crossings at city streets, the engineering features are perhaps not so important from the city's standpoint, as are a number of other matters indirectly connected therewith. The changing of the grade of the railway and the building of bridges necessary to carry the railway across the street, though generally involving many interesting engineering propositions, do really not play a very important part, when one considers the subject from the city's standpoint alone. The prime object of eliminating railway grade crossings from the city's viewpoint, is to so carry the roadway either above or below the railway tracks as to permit street traffic to cross the same, first with safety, and secondly without interruption. It is for this reason alone that the city has found it desirable to spend large sums of money in paying its proportion of the cost of eliminating railway grade crossings in Cleveland.

From the railway company's point of view, the changes that are made when abolishing grade crossings often makes possible certain road betterments, such as a better grade, or a wider right of way, and the building of more tracks. The city, however, seldom obtains either a better street alignment or a better roadway grade than existed before the grade elimination took place.

In considering, from the city's point of view, an estimate, upon a dollars and cents basis, of the benefits derived from the separation of railway and street grades, a rather indefinite problem is presented. To make such an estimate involves placing a price upon deaths and accidents, and assuming the number of such casualties which might occur to persons while crossing the railway tracks at grade. It further requires valuing the loss in

time and money caused by street traffic being interrupted and delayed by passing trains.

We know that it is one of the most important duties of any city government to make its streets, above all things, safe and free from danger, and their traffic subject to as little delay and interruption as is possible. It is due almost wholly to this feature that cities participate in grade elimination work, and seldom, I believe, is an estimate attempted to prove the necessity from financial considerations.

While the city derives but little direct benefit from the changed conditions which take place when railway grade crossings are eliminated, there is, of course, an indirect benefit which accrues to the entire vicinity where the grades of the street and railway tracks have been separated, on account of the safety and the ease of carrying on traffic over the streets.

On the other hand, considerable damage often results locally to property. Abutting land originally improved in reference to the original grade of the street, may be left either considerably above or below the changed roadway grade. This frequently involves a partial or total reconstruction of buildings, and in some cases the change in grade has been so great as to unfit the building for occupancy. The law provides that property so damaged shall be compensated to the amount of such damage, but should on account of the change, the buildings lose their tenants and business go elsewhere, it means that temporarily at least, the entire section surrounding an undertaking of the kind mentioned, is to some extent damaged. Vacant property, which may originally have been of such an elevation, that it fitted the grade of the roadway before the grade crossing work took place, may afterwards, on account of the depression of the roadway, be located so far above the new grade of the street, that no one cares to undertake the expense incident to building upon the same.

This brings about an unsightly appearance, in that frequently the side slopes of the property are left rough and unfinished, allowing mud and dirt to wash down upon the sidewalks. About the only use that is made of some such property is as a location for unsightly sign and billboards. This unfavorable condition may perhaps only be temporary, as there is always a possibility that the land may be improved, in a manner that will fit the new grade of the street, for the reason that after a grade crossing has been abolished the grade of the street is more firmly established than before, and there is greater safety in improving abutting land in reference to the same.

On account of the desirability of separating the street and railway grades, and the tendency of the time to undertake such work as rapidly as the funds therefor can be obtained, there has been an inclination to make only temporary improvements in the vicinity of the railway tracks, as it has been understood that sooner or later, either the grade of the railway tracks or the street, or possibly both, would be changed. As an example of this situation may be mentioned the condition along the line of the Pennsylvania Company. Since 1902, the separation of grades along the Pennsylvania railroad has been agitated, and as a

consequence manufacturers desiring to locate in this vicinity have been at a loss to know what the final results in reference to the railway and street grades would be. Since the work has been begun, however, and the grades established, permanent improvements are being made, as manufacturers see that now a fixed condition has been established.

It is to be regretted that when the work of eliminating grade crossings is undertaken, the improvement of abutting property cannot simultaneously be made. The law, however, gives no power to the city to enter upon private lands in order to build retaining walls, or to grade side slopes, or to change buildings that will in any way interfere with the private rights of the owner. The changes must be confined to the limits of the roadway unless land necessary for the side slopes or retaining walls is appropriated. Appropriations of this kind would often needlessly delay the work, and are therefore undesirable where the same can be avoided.

Where it becomes necessary to either build retaining walls or to grade side slopes upon abutting property, the policy in Cleveland now is to make the doing of this work one of the conditions of the damage settlement. In the early grade crossing work in this city, the damage settlement was made, and the money for the same paid to the property owner, and the latter was allowed to do as he wished as regarded his property. Several cases arose where the property owner, though claiming that he would be obliged to build a retaining wall, or to grade his property, and to plant the same with grass or trees, failed to do this after having received his damage settlement, and as a consequence a very unsightly condition resulted, the sidewalks being covered with mud rolling down from neighboring lands in times of rain or snow. To prevent this, payment of money for damage settlements should only take place after the property owner has properly protected abutting land, and done what is necessary to prevent such an undesirable condition from arising.

The city furthermore is interested in the slightly appearance of the structures that are built, in so far as the view of the same can be obtained from the streets. Should the roadway be carried over the railway tracks, the railings of the bridge crossing the railway should be neat in appearance. Wherever possible, it is desirable that no part of the structure of the bridge extend above the roadway, with the exception of the railings. Deck structures are therefore desirable wherever they can be obtained. The through truss extending above the roadway, or through girders extending over the roadway near the curb lines, often fail to present as pleasing an appearance as an unobstructed roadway such as can be carried over by means of the deck structure.

Where the roadway goes underneath the railway, it was at first thought desirable that the roadway should also be free and clear from all obstructions, and several of the earlier bridges built in connection with the grade crossing elimination, were provided with clear spans extending between abutments placed at the side lines of the streets. This made necessary the construction of deep girders, considerably out of proportion to the

clearance provided between the bottom of the same and the roadway underneath. In later structures, curb supports have been generally adopted, and as a consequence, the girders carrying the bridge have been made less deep and present a neater appearance.

Though theoretically it might seem a good principle to adopt, that the roadway should be left clear and free of permanent supports, there is hardly a case in the city where numerous temporary encumbrances have not been constructed at the curb lines in the immediate vicinity of such grade crossing bridges. Reference is made to the many telegraph and trolley poles, water hydrants, trees and like obstructions.

As there is seldom need for vehicles to stop alongside the curb underneath the bridge, there is really less argument in favor of a wide unobstructed roadway in such a location, than there would be in other portions of public streets. It can therefore be stated, that in spans of over forty (40) feet, column supports at the curbs are not objectionable, and may be incorporated in the design.

From the city's point of view, therefore, railway grade crossings may be considered undesirable, in that they endanger the lives of its citizens, and in that they impede and obstruct street traffic.

In the elimination of existing grade crossings, the city is interested in so planning the work that no prohibitive grades may be introduced in the street approaches; that clearances under railway bridges for the roadways be ample; that as little change as possible should occur in the street grades, so that the property damage may be kept to a minimum; that during the construction work street traffic be treated with as much consideration as the railway traffic, and adequate provisions be made to maintain such traffic where possible, and finally, that due consideration be given to the sightliness of the structures and their surroundings, so that no lasting damage due to an unpleasant appearance be caused.

April 9, 1912.

Elimination of Grade Crossings

BY ALBERT J. HIMES.

There are a few great lessons which, for comfort, for convenience and success, should be learned early, and learned thoroughly. One of these lessons is the value of co-operation, and the elimination of grade crossings is something in which co-operation is imperative. The general elimination of grade crossings is a subject of such stupendous magnitude that it must be



FIG. 1

approached with caution. It requires much calm and patient consideration by the most unprejudiced minds. There must be sincere co-operation by the interested parties.

In 1884, it was estimated that to eliminate all the grade crossings in the state of Massachusetts would cost \$100,000,000, and in 1901 the estimated total capitalization of all steam roads in Massachusetts was \$97,000,000. In Chicago, \$46,500,000 had been spent upon the elimination of grade crossings up to the year 1908, and the expenditure of \$60,000,000 more was contemplated. Such expenditures are too great to be undertaken suddenly or without a careful determination of the necessities and benefits of each particular case and an agreement to share the burdens

in an equitable manner. A good example of co-operation in these things is the manner in which the Nickel Plate share of the grade crossing elimination was handled in Buffalo. When that city was ready to undertake the work, the Nickel Plate did not have the funds necessary to do its part and the city in a very commendable spirit loaned the railroad its credit. The obligation has now been discharged and all parties are satisfied. It would have been very difficult for the Nickel Plate to proceed with the work without such assistance.

There should be co-operation among all concerned when planning such work. Every case is a special problem and but remotely related to what has been done elsewhere. This might not appear true to the thoughtless observer, but to illustrate, in the city of Worcester, Mass., able engineers prepared five different plans for separating the crossings before one was adopted. A fine example of a lack of co-operation in planning is the manner in which the people of East Cleveland sought to oblige the Nickel Plate to depress its tracks through that village. Fig. 1 shows the location of the Nickel Plate through Cleveland and its suburbs. The Nickel Plate is shown by the line that parallels the Lake Shore west of the river, passes through the southerly

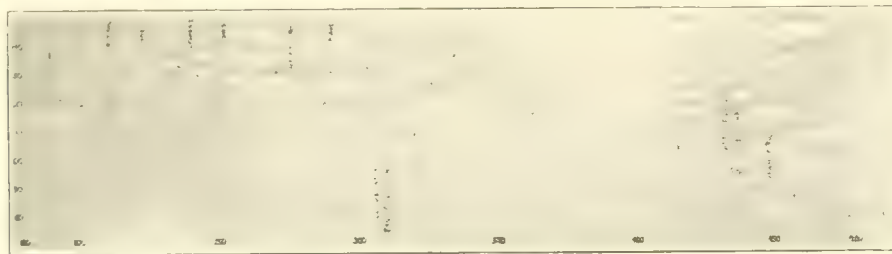


Fig. 2

and easterly parts of the city and returns to the lake several miles eastward. It is intersected by 106 (97 grade crossings and 19 others) streets and the average cost of eliminating the crossings is more than \$40,000. Fig. 2 shows the profile of the grades, both old and new, from Ninety-third street through East Cleveland to Ivanhoe road. The heavy line shows the new grade as elevated above the East Cleveland streets. Looking at the summit of the old grade near Cornell road, it is readily seen that to place the tracks below the streets in East Cleveland would have involved an enormous cut, two miles in length, from Euclid avenue westward. The excavation would have been mostly hard shale rock and the expense fabulous. Moreover, such a grade would have left the Cleveland Short Line railroad so far below the ground surface when leaving the Nickel Plate line near Quincy avenue as to make its present location impossible. But the people of East Cleveland finally agreed to the track elevation and today when the work is about 95 per cent complete, they appear well satisfied.

Besides lack of co-operation in planning, this incident illustrates another very serious difficulty encountered when dealing with the public. It is the general lack of imagination which

would enable men to foresee the effect of proposed changes. Pessimism seems the order of the day and not until the battle is fought and won and the smoke cleared away can they understand just what is contemplated in the plans.

Co-operation is needed also in construction. It is a very serious matter to interfere with the tracks over which are operated all the trains of a railroad. There are many details to be attended to and there must be careful watchfulness to avoid accident. In the Nickel Plate work, now nearing completion, there were concerned in the work two railroads with their several departments, two cities, the public service corporations of those cities and the various industries along the line. Without co-operation among these several interests the performance of so large a piece of work would be almost interminable.

Throughout the whole of the work, the attitude of the City

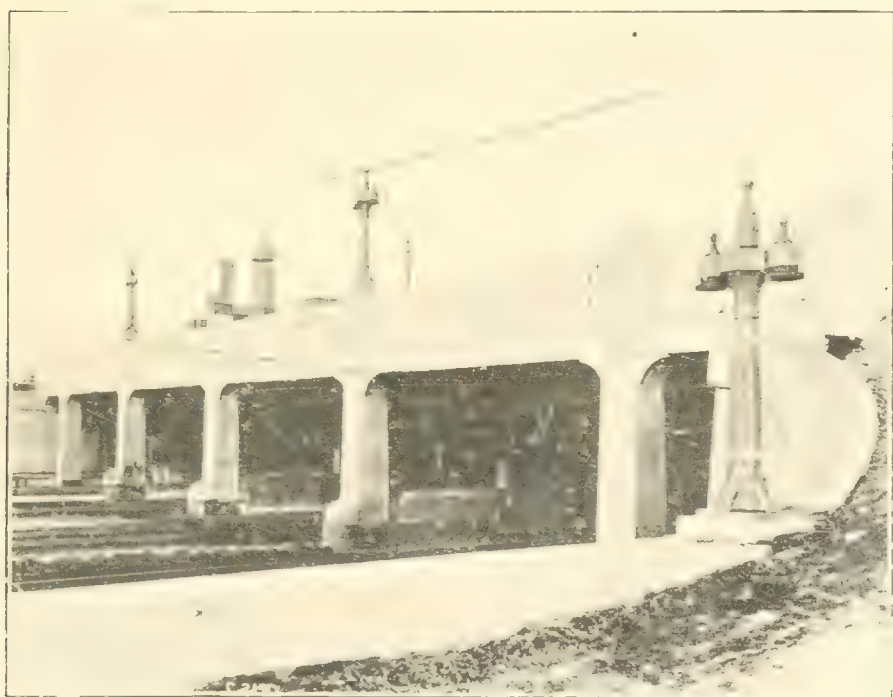


FIG. 3

Engineering Department has been one of hearty co-operation. There has been great breadth of view and good judgment in handling the numerous difficulties encountered and it is proper to say that no work in which the writer has engaged has progressed from start to finish with so little friction. This applies to the portions of the work beyond the jurisdiction of the city as well.

In designing the bridges for crossing the streets, due regard should be had for the surroundings. A place of especial beauty should not be marred by an unsightly bridge and a street occupied by industries alone does not deserve the expenditure of a large sum of money for the sole purpose of ornamentation. When an artistic structure is needed, there must be co-operation between the architect and the engineer. Artists are proverbially unyielding. They are such loyal devotees of their profession

that beauty must be placed above all else and it is at times hard for them to see that a bridge to carry railroad trains must be constructed in accordance with certain mechanical laws. I am



FIG. 4

told that today some of the better artists are departing from this time-honored attitude and doing commercial work. In other words, they are accepting engagements where certain conditions are predetermined by business considerations and they are adding what they can of art to improve appearances. We can now look forward more hopefully to co-operation in bridge building.

An effort has been made to secure a set of photographs illustrative of the best work that has yet been done in artistic



FIG. 5

design of street bridges. In Chicago, all bridges over the boulevards must henceforth be designed by architects. Fig. 3, a B. & O. Chicago Terminal bridge over Ogden boulevard, shows one

result of this rule. It is an ordinary steel plate girder bridge with a fascia of concrete. The fascia cost \$5,200. The concrete posts cost \$400 each. There seems to be a feeling that a bridge



FIG. 6

of steel is inherently ugly, and it is common to seek beauty in concrete. Fig. 4 shows the old steel arch over East boulevard in Cleveland. It was designed by Schweinfurth and created so much favorable comment that requests for photographs have come from numerous cities.

It is believed by the writer that in seeking the beautiful in bridge design, dependence should be placed upon the general lines and ensemble of the structure rather than upon any fine



FIG. 7

ornamentation. In support of this view, Fig. 5 and Fig. 6 are shown. The first is a picture of the Washington Bridge over the Harlem, in New York. Fig. 6 is the Paulins Kill viaduct

on the Lackawanna Cut-off. The beauty of these structures is of the first order and it comes wholly from the major features of the design. They are not grade crossing bridges, but illustrate



FIG. 8

well the point it is desired to make.

Fig. 7, the Forest Park bridge, on the Wabash, in St. Louis, is one of the earliest attempts at concrete ornamentation. W. S. Newhall, of Cleveland, was the chief engineer of the road when the bridge was built, and to him are due our thanks for the picture from which this view was made. It is a remarkably pretty bridge. The concrete fascia for this bridge cost \$1,000.



FIG. 9

I wish to call your attention especially to two references to the abolition of grade crossings given in the announcement of this meeting. The first is *Engineering and Contracting*, Vol. 36, pages 442 to 445 —

"Methods of Railway and Street Grade Separation in Cities", by R. H. Whitten. This is a complete summary of general conditions, academic in a way, but worthy of careful study. The second is *Engineering News*, Vol. 61, pages 348, 349—"Grade Crossing Elimination", by A. D. Chidsey, Jr. This is a statistical article, showing the general status of the work throughout the whole country, covering legislation, amount of the work and costs. It is useful for reference.

Mr. Geo. H. Tinker, bridge engineer of the N. Y., C. & St. L. R. R. Co., has consented to join in this discussion, and I want to say for your information that Mr. Tinker has for several years been chairman of the Committee on Masonry of the American Railway Engineering Association and has given much time and study to concrete construction. What he has to say on that subject is therefore entitled to much weight.

April 9, 1912.

Grade Elimination and Railroad Bridges

BY G. H. TINKER.

I have been asked to make a few remarks upon some of the details of construction in connection with the design of grade elimination and railroad bridges. This subject has been studied by railroad employes for a number of years. From experience with the early bridges, there have been two or three points developed which it seems necessary to consider in the design of such structures. Some of the early bridges which carry trains over the street are quite noisy and are objectionable on that account. If any one will visit Lakewood and stand under Clifton Boulevard bridge, he will understand what I mean. The rails rest directly upon the floor plate, held down by clips, and every time a train goes across, it produces a roaring sound which can be heard for a long distance; in fact, it is hardly possible to hear anything else while the train is on the bridge. It seems desirable to avoid this objectionable roaring, and considerable study has been put upon that point.

To determine how the noise could be best reduced, bridges of various types in several cities have been observed with that point in mind. In the city of Pittsburgh, near the Pennsylvania station, there are two bridges which carry the Pennsylvania tracks across Penn avenue and Tenth street, and it is remarkable how little noise can be heard from a train crossing these bridges. When the reason is sought, it is, at first, difficult to see. However, on both bridges there is a deep bed of ballast which carries the track, so that the effect is an ordinary roadbed crossing the street by a bridge.

In the city of Chicago, there are a number of bridges which are apparently of similar construction, and yet the noise is quite pronounced. It is probable that there is not very much ballast upon the deck of these bridges, and that fact has apparently considerable effect upon the amount of noise produced. There is also a great deal of noise produced by the passage of street cars underneath the bridges, and in the case of some bridges the street cars make a great deal more noise than the railroad trains do. Where the beams forming the floor of the bridge are exposed below, forming air pockets between them, the passage of the car sets up a reverberation. There is a similar reverberation noticeable in a through girder bridge. The sound seems to rebound from one girder to the other, back and forth, until it produces a continuous roar.

It is also noticed that where the floor of the bridge is heavy and there is considerable concrete, the noise is much less. At the Detroit avenue bridge over the Nickel Plate tracks in Cleve-

land, the bridge carries the roadway with the street car tracks across the railroad. The beams are exposed below, but they are covered with concrete to a thickness of some 2 inches on all sides. There is a sand and brick pavement on top of the concrete slab, and the street car tracks are carried upon steel ties which rest directly upon the beams. There is a slight reverberation noticeable from the passage of street cars over that bridge, but the noise is not objectionable.

Following out this line of investigation, the observations seem to indicate that if a bridge be constructed with considerable depth of ballast that the vibration of the rails and the parts of the bridge would be reduced. And, further, that if a smooth under-surface of the floor be obtained that there will be very little opportunity for a reverberation underneath the bridge. This is very well illustrated by the present Euclid avenue bridge on the Nickel Plate railroad. The noise from the passage of trains there is very slight. A person may stand under the bridge and hear ordinary conversation with ease while a train is passing. The space between the beams is filled with concrete, producing a smooth under-surface, and there is about 2 feet of ballast on top of the slab which carries an ordinary roadbed. So we think that the reduction of noise is accomplished by attention to these details of construction.

Another point which has caused a great deal of thought is the nuisance from the dripping of water through the bridge floor upon the street below. This is objectionable even when the amount of water passing is quite small, because the water passing through ballast, trickling down through the interstices of the floor slab collects various substances such as lime, grease and iron rust, which, dripping upon passers-by, may ruin their clothes. Therefore, it has become necessary, and is required by ordinance in some cases, that bridge floors should be waterproof.

A great deal of study has been put upon the subject of waterproofing masonry, and especially the waterproofing of bridge floors, which seems to be one of the principle things requiring waterproofing. The American Railway Engineering Association, through its Masonry Committee, has had this subject under investigation. The Committee has made three progress reports, but has not, as yet, published any definite conclusions. The Committee has found this to be a large subject, and one upon which almost any proposition may be proved if the contradictory instances are ignored.

There are several companies who are exploiting various waterproofing compositions. They have had a large growth in the last few years, partly because of the necessity for waterproofing structures of this kind. There are many substances which are more or less impervious to water. In fact, nearly every substance is impervious to a degree; some very slightly, some very much so. A wooden plank offers a certain resistance to the passage of water; so does a slab of stone. Under some conditions considerable water will pass through either. Various substances of a hydrocarbon composition—*asphalt, coal tar and petroleum products*—seem to be quite impervious to water under

certain conditions. Many substances are on the market for incorporation with the sand and cement to make impervious concrete. The theory is that these substances make the concrete so dense that water cannot percolate. Extravagant claims are made for some of these materials. Some engineers believe that for the waterproofing of masonry—and masonry now-a-days means concrete—about the best thing is concrete. The accepted method of waterproofing a concrete slab in a bridge floor is to place upon it a layer of $\frac{1}{2}$ -inch to 2-inch thickness of some of the asphalt, coal tar or petroleum product gums, with which may or may not be included several layers of burlap or felt paper. Now, a small surface covered with these substances will hold water indefinitely, but when you spread them over a large expanse of bridge floor, there are other difficulties to be met, and the greatest of these is the expansion and contraction from temperature. Asphalt itself, if its condition remains unchanged, is quite impervious to water, but if it contracts through cold, and cracks, the water will pass through the crack. It takes a very small crack to produce a leak which is objectionable in a bridge floor, and therefore it is necessary to have a substance which will expand and contract with the slab and not crack. This leads to the other extreme, that is, a substance so soft that when it becomes warm it will run. There are bridge floors in Chicago which leak asphalt. It is therefore clear that it is not a simple subject, and for any man to guarantee off hand that any particular waterproofing composition will make a watertight bridge floor is rather hazardous. It is true, instances may be found of bridge floors which are apparently watertight, but there are more instances where this is not true. I think I may say that a well built slab of concrete is fully as impervious as a poorly built slab with any style of waterproofing.

In connection with the above method of waterproofing bridge floors, the asphalt, coal tar or petroleum products used require protection against abrasion and damage from external causes. This requires a still greater thickness. Many bridge floors have been built with a protection of brick on top of the asphalt. They have been fairly successful from a waterproofing standpoint, but the finished waterproofing adds in the neighborhood of 6 inches additional thickness to the bridge floor, and it is the opinion of a good many that that 6 inches could be better utilized by placing 6 inches of concrete on the floor.

In the bridges recently built in Cleveland by the Nickel Plate no foreign waterproofing substance has been used. An attempt has been made to construct a concrete slab which would be in itself as nearly waterproof as it is practicable or desirable to make. This has proved satisfactory. When the Cedar avenue bridge floor was built, the ends of the bridge were dammed up, the trough so formed was filled with water and allowed to stand for several days. No water whatever came through at any point of the slab. A little water ran through the dam and down over the back wall, and seeped through the joint between the bridge seat and floor slab. At the center bent there is a drainage system provided to carry what water might percolate through at that

point down to the gutters. Through some slight defect in the formation of this drainage some water seeped through there and dampened the concrete, but at no point of the bridge did any water drip.

One of the most essential things in the successful waterproofing of a floor slab is to get rid, in the most direct manner, of all the water that accumulates. That means that a drainage system must be provided which will be ample to take care of all of the water which can be collected upon the bridge floor. This sounds simple, but it is quite difficult. These drainage systems have to be carried some distance; they have to pass around a great many angles and eventually reach the level of the street gutters or of the sewer. At the Euclid avenue bridge such a drainage system is in place. When the bridge was first completed, it was discovered that at some point between the bridge floor and the sewer the drain pipe was clogged, with the result that the water did not run away, but stood in the drainage gutter and eventually soaked through the concrete. This illustrates the care and painstaking attention to detail necessary to secure the desired results. This pipe has since been cleaned out so that water runs away readily.

The essential points in constructing a watertight floor slab are: Dense concrete—the denser the more impervious; intelligent study and design in the location of expansion joints; the provision of an ample drainage system; careful workmanship and constant supervision during construction.

Another point which has developed from experience with bridges over the tracks where the under-clearance is low, is that the blast from the engine has a very detrimental effect on the structure overhead. In the city of Chicago it has been determined that where the clearance is about 18 feet the steel will be worn away by the engine blast at the rate of about $\frac{1}{4}$ inch in ten years. That means that the flange of an I-beam would be so much deteriorated in ten years that the beam would have to be replaced. This has occurred in some instances in Chicago.

At the Detroit avenue crossing of the Nickel Plate the clearance is 16 feet 3 inches, which is the general rule in Cleveland. The I-beams in this case are covered with concrete to a thickness of $1\frac{1}{2}$ to 2 inches; it was found in the course of a few years that the engine blast eroded the concrete, so that in about five years there is a bare streak of steel over the center of the track. At the Adelbert road and Cornell road bridges it was decided to place cast iron plates immediately over the center of the track. These smoke plates are about $\frac{1}{2}$ inch thick. The engine blast will not be as destructive as upon steel, the cast iron being harder, and when the plates are destroyed they can be replaced with little trouble and expense. In some cities a wood plank has been used for this same purpose. In the city of Philadelphia, the Philadelphia & Reading railroad placed a wooden ceiling under their steel bridges. These gave fair satisfaction for several years.

Our experience is that a concrete covering will be satisfactory for a few years, but where the head room is low, as is apt

to be the case in cities, that it will not protect the steel permanently. It must then be replaced, and it is well known that to repair an old, worn surface of concrete is likely to prove a difficult and costly operation.

One point in connection with the subject of co-operation. In some cities, there has been a tendency to design the work of grade elimination at the least possible expense. That means the lowest height for retaining walls, the least difference between the grade of the railroad and the grade of the street and the least thickness for bridge floors. This is unfortunate. While it is true that a bridge floor may be built quite thin, it is not satisfactory; it leads to the objectionable designs which I mentioned. Wherever the bridge floor consists of simply I-beams and steel plate, which is about as thin as a bridge floor can be made, there will be noise and leakage. In order to reduce the noise to a minimum, to reduce leakage to a minimum, it is necessary to have a reasonably thick bridge floor. In recent designs in the city of Cleveland about 4 to 4½ feet has been adopted. With this thickness a very satisfactory floor can be made, and it is believed that the additional expense due to the increased height and length of approaches is offset by the greater length of the life of the structure, and by the greater satisfaction which accrues from its use.

April 9, 1912.

Embellishment of Railroad Crossings

By FREDERIC W.M. STRIEBINGER, ARCHITECT.

If I may digress for a moment, in the broadest sense of the term, architecture in any form, should be educational, and not only studied for the safety and comfort of the public, but for its *artistic* development as well. *It is a subtle power in the community* which few realize, interpreting the spirit of the age and stamping it with a character of its own.

Let us glance at the past.

Did the Egyptian rulers leave any impress upon history with their wonderful pyramids and temples? Did Greek architecture with its refinements and beauty of line and curve, cast any influence upon the history of its people? Did the Roman Forum with its stately temples teach the Romans any lessons? Did the English and French cathedrals with all their majesty impress the people of their day? Yes! And, not only the people of their day, but to the present and through all the future years, as long as one stone stands upon another, these wonderful creations will lead men to higher and nobler ideals and teach civic pride.

But, art in architecture is not confined to buildings alone. Let us look at its application in some of its broader phases. How many public squares surrounded by beautiful public buildings have been made or spoiled by the proper or improper treatment of the square itself? How many public parks, beautiful in themselves, could be made more pleasing by the introduction of a few carefully considered features. With just a little investment and a thoughtful study of the subject these breathing spots of the city could be made most attractive.

If we stand at the old historic Louvre in Paris and look down the Avenue de l'Opera with the beautiful Opera House at the end of the street, silhouetted majestically against the sky, and see this fine, wide avenue, bounded on both sides by the beautiful buildings of uniform height and design, where about one hundred years ago was a network of crooked streets and tumbled down buildings, we can appreciate what Napoleon III and his adviser, Baron Hausmann, did for Paris.

Again, if we stand upon the deck of one of the little mosquito boats darting along the Seine from quay to quay, and see the magnificent bridges, the work of some of the greatest artists of France, we can appreciate the care that has been given to these designs to make them things of beauty.

So I might enumerate feature after feature that make Paris "The City Beautiful", and show that not only does art in civic improvements please and elevate, but that it brings with it in *plain, cold, business terms, a commercial value* by attracting to this city from all parts of the world thousands upon thousands

of visitors, who leave their gold and go away satisfied and inspired to higher ideals and aspiration.

In this same spirit the elimination of our grade crossings should be studied, combining *practicability of arrangement with artistic beauty*, or in other words the *practical made beautiful*.

To illustrate, let us examine and see how this problem has been solved in Europe:



FIG. 1

PLATES 1 AND 2.—*Pont D'Austerlitz, Paris*.—Illustrate how an elevated railway running through a crowded city emerges from the street and crosses the river Seine. Notice the curved road-bed, also how well the under portion of the structure has been designed, as seen from the small boats plying up and down the river.

PLATE 3.—*Viaduct de Passy, Paris.* On this bridge the elevated roadway was added after the bridge had been built. Notice the splendid design of the structure, the well managed



FIG. 2

distribution of ornament and plain surfaces, and the splendid sculpture; also, the general balance of design throughout the entire structure.



FIG. 3

PLATE 4.—*Dresden Railway Station.*—In this structure the railway tracks are brought into the station, at an elevation which gave a splendid opportunity for design, and see how well the

conditions have been met. What a splendid gateway to a large city.

PLATE 5. *Edinburgh, Princes Street.*—This plate shows



FIG. 4



FIG. 5

Princes street, the main thoroughfare of Edinburgh, with beautiful gardens along the side, which is built upon the roof of the public market house. In the distance Edinburgh Castle and the

Art Museum. Here the railway comes into the station at a lower level than the street, and see how well this problem has been met. What a general aspect of monumentality there is about it, and yet how simple the solution.

PLATE 6.—*L. S. & M. S. Lake Avenue Grade Crossing.*—This place is a reproduction of the writer's design for the track

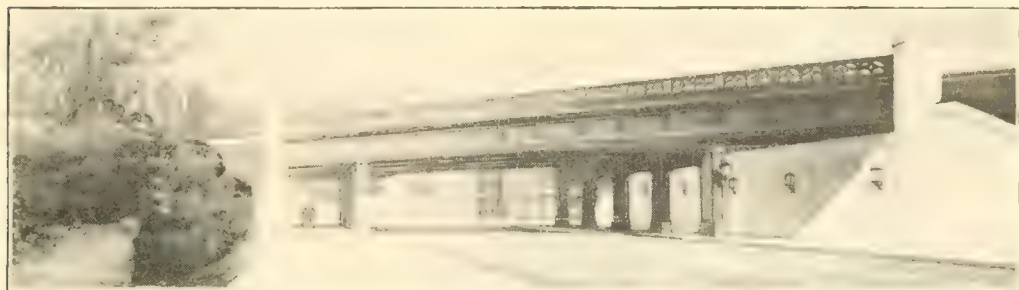


FIG. 6. (WASHED DRAWING)

elevation of the L. S. & M. S. railway at Lake avenue of this city. An attempt is made here to retain simplicity in the design of the concrete abutments and confine the decorative effects to metal work of the bridge. Owing to its proximity to Edgewater Park, this structure was made more elaborate than the average grade elimination.

April, 9, 1912.

Discussion

Mr. Irwin:—

I would like to say a word in conclusion. I believe it is a well known fact among American bridge engineers that if one wants to study bridge engineering, the text books advise, "Don't go to Europe to do it." But the point I want to make is this, that in a great many of the pictures shown, the approaches to the bridge were very liberal, showing masonry profuse in curves, pictures of statues, etc., and the span which supports the roadway we find to be exceedingly objectionable in this country; *i. e.*, the truss form of bridge, which, to the layman, presents merely a conglomeration of long pieces of steel without "lines", and so on. In the city of Cleveland this type of construction would be absolutely prohibited for carrying tracks over streets of any importance.

Now the study of bridge building in a great many cases emphasizes the peculiar idea the Europeans seem to have in regard to elaborate work, which they treat as the largest end, often slighting the span in economical detail and structural desirability.

A great many of the bridges for the elimination of grade crossings in this city have not been designed with any thought of the artistic. They were built on practical lines and stopped at that point. Latterly, however, much attention has been given to treating the structures in such manner as to bring their appearance into harmony with the surroundings and to obviate any discomfort in the way of noise to persons living near the tracks or to traffic passing under the bridge.

Finally, I believe that the study of European bridges will yield us very little of practical value in the design of bridges for grade crossing elimination; and since architects do not always agree as to what is proper, it is hardly to be expected that the engineer and architect will do so.

It seems, therefore, that the engineer would do well to give his best thought to the design of a good and economical bridge instead of trying to make it a part of one or more conflicting schemes of "landscape gardening".

ABOLITION OF GRADE CROSSINGS

- Blakemore, A. W.** The Abolition of Grade Crossings in Massachusetts. 1905.
- Canadian Engineer**, Feb. 12, 1909. The Railway Crossing, by F. L. Somerville. Discusses the development and proposed elimination of grade crossings.
- Cleveland Chamber of Commerce.** Abolishment of Grade Crossings: Report of special committee, Dec. 18, 1900.
- . Report of the committee on city finances recommending the authorization of a bond issue for the elimination of grade crossings. Special election July 22, 1910.
- Cleveland Engineering Society Journal**, Dec., 1910. Railway Grade Crossing Elimination in Cleveland, by Robert Hoffmann. Explains the general conditions, reviewing the history of grade separation, and illustrating and describing construction work. Discussion.
- Engineering and Contracting**, Oct. 25, 1911. Methods of Railway and Street Grade Separation in Cities, by R. H. Whitten.
- Engineering News**, Apr. 1, 1909. Grade Crossing Elimination, by A. D. Chidsey, Jr. Gives a condensed summary of the status of grade crossing abolition, covering legislation, amount of work and costs.
- Engineering Record**, Sept. 7, 1907. Elimination of Grade Crossings in New York Central Electric Zone. Illustrates and describes the High Bridge and Morris Heights Stations where overhead bridges are used.
- , April 17, 1909. Abolition of Railroad Grade Crossings in Philadelphia. Describes work of elevating tracks which will cost about \$10,000,000.
- , Oct. 30, 1909. Grade Crossing Elimination in Worcester, Mass., by C. H. Gilman. Illustrates and describes changes made necessary, including the elevation of about 20 feet of over four miles of railroad, a new station, change of grade of fifteen streets, and the construction of three new streets.
- Municipal Affairs**, Dec., 1901. Abolition of Grade Crossings, by Charles Zueblin. An illustrated article reviewing what has been accomplished and what should be done in various cities of the United States.
- Municipal Engineering**, Aug., 1901. The Abolition of Railroad Crossings at Grade. From the report of L. M. Hastings, offering plans for solving the various problems arising, and making his recommendations.
- Outlook**, Aug. 27, 1910. The Cost of Saving Life. State aid for grade crossing eliminating.
- , Oct. 7, 1911. Death-traps.
- Railway and Engineering Review**, Nov. 21, 1908. The Kinsman Road Improvement in Cleveland, O., by D. M. Taylor. An illustrated description of extensive grade crossing elimination.
- St. Louis Street Railway Club**, Proceedings, May 14, 1909. Grade Crossings, by H. J. Pfeifer. Discusses matters in connection with the elimination of grade crossings. General discussions follow.
- Scientific American**, Sept. 11, 1909. The Elimination of Grade Crossings.
- U. S. Census.** Statistics of cities having population of over 30,000, 1907. Steam railroad crossings, classified by character.

Building Code Suggestions with Special Reference to the Cleveland Building Code

By VIRGIL G. MARANI,

Former Inspector of Buildings

The new Municipal Code, Section 7, Sub-Section 13, granted each municipality the right to make its own building laws without further legislative interference.

On March 9, 1903, the Mayor appointed a Building Code Commission to prepare a suitable, complete and *comprehensive* code of building laws.

The Code became operative on July 5, 1904, and from that date to the present time has been the object of much criticism by engineers, architects and builders from every part of the Union.

The compiling of this conglomeration of specifications, building regulations and conditions cost the city about \$32,000.

It can hardly be conceded that the commission complied with the Mayor's request "that they prepare a comprehensive code of building laws." Plans returned and rejected to be re-drawn, involving loss of time both to the architect and the builder are proofs, in a measure, of the anything but comprehensive state of the code.

The endless chain of Board of Appeals cases is further proof of this assertion, and it is interesting to note that each case of the Board of Appeals, if only of one hour's session, takes the time of public officials to an amount of about \$12.00, besides interruption to the regular duties of the Mayor, City Solicitor, City Engineer and Building Inspector.

When the Building Code passed the City Council, there was an average of over 800 active building operations scattered over 45 square miles of territory.

Upon this field of operation it was the duty of the Building Inspector to enforce and see carried out the 1,100 building regulations imposed by the Code, and for this purpose the Code allowed only the following outside inspectors: One for iron and steel, one for masonry, one for carpentry, one for heating and one for elevators.

It is evident that the Code is certainly strong on legislation, but lamentably weak on execution, and therefore only such portions of the Code are considered as can be enforced with a handful of men scattered over 45 square miles.

In a great many sections of the Code the word "Inspector" is used; this is defined as follows:

Section 292.—Inspector.

"The Inspector of Buildings of the City of Cleveland."

Section 176 states he shall appoint all employes, etc.

Section 187.—"He shall pass upon all questions, etc., etc." "He shall acknowledge receipt of all communications."

Section 188.—"He shall examine all violations, etc."

Section 190.—"He shall keep a book, or books, in which shall be recorded the location and character of every building."

Section 192.—"He shall make a monthly report to the Mayor."

Section 193.—"He shall make an annual estimate, etc."

Section 202.—"Permits must be obtained from the Inspector of Buildings." "He shall determine when permits are not required."

Section 238.—"He shall issue with permit a metal tag of a serial number, a duplicate of which shall be sent to the City Auditor."

Section 240.—"He shall notify in writing before revoking a permit."

Section 262.—"He shall call Board of Appeals meetings."

Section 355.—"He shall approve all reports of mill, shop and field work, etc."

Section 356.—"He shall supervise all tests of materials."

Section 365.—"He shall determine all special cases of floor loading by calculation."

Section 473.—"He shall receive reports of special concrete inspectors, and require them to pass examinations."

Section 520.—"He has to inspect the piping, wiring, etc., before lath and plaster is applied."

Section 535.—"He has to direct fireproof floor tests."

Section 653.—"He has to grant permits for changing or obstructing stairs, etc."

Section 725.—"He is responsible for the proper distribution of temporary loads on a building being erected."

Section 726.—"To prevent overloading on floors of factories, workshops, storehouses, etc., the Inspector, or a competent person, employed by the owner, shall calculate the safe loads."

Section 854.—"He has to issue special permits to allow grooms and coachmen to live over stables."

Section 875.—"He has to see the theatre provisions of this section carried out."

Section 969.—"He shall direct all tests for gas piping.—First, when roughing-in is completed and before floors are laid; second, when the entire building is completed and the work is ready for gas fixtures."

Fifteen minutes is minimum time for test.

Section 974.—"He shall order the removal or repair of any improper system of gas piping."

Section 1028.—"He has to approve all applications to erect signs, etc."

Section 1040.—"He shall serve fire escape notices."

Section 1083.—"He shall issue elevator permits."

Section 1086.—"He shall inspect all damaged elevators and issue permits to re-operate."

Section 1088.—"He shall notify owners of dangerous or damaged elevators, and issue certificates when same can be re-operated."

In the conditions imposed by Sections 189, 191, 198, 236, 625 and others, not so much is expected of the Inspector of Buildings, for in these Sections the following wording is used:

"The Inspector of Buildings shall regularly inspect, or cause to be inspected."

"He shall keep, or cause to be kept."

"The Inspector of Buildings—shall make or cause to be made."

"Notice shall be given the Department of Buildings."

But this latter wording only confirms the supposition that "Inspector" being defined in Section 292, was defined so that

when mentioned, his duties might not be passed to some subordinate.

This appeared to be the view taken by the Henke Building Commission when I gave testimony before them.

A curious feature of the Code is found in Section 202—Permits.

This Section calls for a permit "before commencing or proceeding with the erection, construction, enlargement, alteration, *repair* or removal of any building, structure, etc."

While Section 220—When Permits Not Required—states in part as follows:

"Permits are not required for minor interior *repairs* where there is no interference with the construction of a building."

"Permits are not required for *repairs* or partitioning off in buildings which do not involve any change in their supporting walls, members or structural parts—"

"Permits are not required for fences, signs or billboards, except as provided in Title 3, Part 3."

(Title 3, Part 3, refers to occupancy of public property only.)

After reading Section 220, it is somewhat of a surprise to find Sections 694 to Section 716, regulating minutely the location, size (even to a margin of $1\frac{3}{4}$ inches), material and illumination of billboards for the erection of which no permit is required, though a billboard is a structure, and under Section 202—a permit should be required.

When I raised the question of billboards being erected on the roofs of buildings without a permit and of a size much larger than is allowed by Section 705, the City Solicitor stated in a letter dated May 25, 1912, in part as follows:

"I cannot think it possible that the use to which an addition to a building is to be put can make very much difference, and if such billboards, when erected on top of buildings, are either unsafe or unsanitary, I have little doubt such erection can be prevented."

Of course, such billboards could hardly be unsanitary, and the question of safety being an easy one to determine, there was nothing more for the Building Department to do.

The writer disagrees with the Law Department, and considers that it makes a great deal of difference as to what use the addition to a building is to be put.

The City Solicitor, in a letter dated May 25, 1911, said this of the Billboard Situation:

"The Billboard Situation has been one of the constant embarrassments of the Department of Buildings for many years—it is not competent for cities or even state legislature to restrict the erection of such display boards otherwise than may be demanded by public health or public safety."—"It seems to be quite clear that no prosecution can be successfully conducted for the erection of a billboard unless the board is either unsafe or unsanitary."

We may well ask the question then, that if it is true according to the opinion of the Law Department that the Code cannot

restrict the building of billboards unless they are unsafe or unsanitary, this argument must apply to the many unreasonable restrictions in the Building Code, relating to structures which have no relation either to the safe or sanitary features of these buildings?

The Board of Appeals—the duties of which are prescribed in Sections 258 to 265, is another curious feature of the Code.

Section 263—Powers of the Board—reads as follows:

“The said Board shall have power to call in such other testimony bearing on the case as it sees fit. Should such Board, or a majority thereof, be of the opinion that the Inspector’s refusal to issue the permit applied for, or that the revocation of such permit was unauthorized, they shall, in writing, order the said Inspector to issue or re-issue such permit, and the Inspector shall immediately upon receipt thereof, accompanied by the required fees, if any, comply therewith.”

When the writer had occasion to call a meeting of the Board of Appeals to settle some ambiguous question of the Code (and this was very often), the City Solicitor always drew attention to the fact that the power and duties of the Board must not be misunderstood by those seeking redress, as the Board could in no way rule other than was specified in the Code. All the Board could do was to interpret the Sections in question, and among themselves decide as to whether the Building Inspector was correct in refusing to grant, or in revoking a permit.

Section 953, in part, states that a blacksmith shop shall not be built closer than 30 feet to any building of the First Grade—Hotel—Tenement—Dwelling, or office, etc.

The Building Department, because of this Section, refused a permit to a Drop Forge Company, but was overruled by the Board of Appeals, who did not consider the attendant evils of a drop forge concern as serious as those of “the village blacksmith”.

On Oct. 14, 1909, the question of the use of limestone in the concrete of the Ball Park was taken before the Board of Appeals. The records read in part as follows:

“The Board of Appeals is of the opinion that limestone is prohibited in concrete construction and that the interpretation of the Inspector of Buildings is correct and in accordance with the Building Code.

“It is, however, the opinion of the Board that this restriction of the Code, being wholly intended as a fire protective measure, should not be made applicable to the type of construction in question in which the danger from fire, and the consequent necessity for the use of absolutely fireproof materials, is so greatly minimized.

“The Board does, therefore, instruct and authorize the Inspector of Buildings to allow the use of limestone in the proposed structure.”

This ruling of the Board was good, common sense, but hardly consistent with the statement already quoted, to wit, “The Board has no power to change the Code or grant concessions, but can only decide upon the Inspector’s interpretation of the point in question as written in the Code.” In this case the In-

spector's interpretation was agreed upon by the Board, but a deviation from the Code allowed.

Under date of April 7, 1906, the Board of Appeals met to consider the case of Architect J. Milton Dyer, for the National Malleable Castings Company. Permit was refused on the Building Inspector's interpretation of Section 759, Title 30, which limits the undivided area of buildings and calls for division of these areas by proper fire walls.

The Board of Appeals' finding was as follows:

"Upon full consideration of the appeal, the Board of Appeals is of the opinion that the opposition of a limited space in buildings to be used for the above purpose, or for the storage and working of materials in which there is employed no oils, waste or combustible material of any description, would be unreasonable, and therefore directs the Inspector of Buildings to disregard such requirements as to sub-division walls as will interfere with the construction of the building shown by the plan submitted."

This was another case of good judgment, but as stated, not consistent with the statement, "This Board has no power to grant concessions or change the Building Code."

It is amusing to note that at this appeal meeting the question of the height of the chimney was taken up, the Building Inspector refusing to grant the permit because under Section 598, the height of a chimney with a flue area greater than 96 square inches could not be less than $33\frac{1}{3}$ times the average diameter of the flue.

The Building Inspector, in his letter to the Board, states in part as follows:

"The application made for the permit for this building describes a chimney of about 60 feet in height, with a 45-inch flue. The Code requires a chimney about 125 feet high when the flue is of such size."

The Board's finding upheld the Building Inspector, though I question very much if the chimney was built to this height, and here I might add that it was lucky the National Malleable Castings Company did not show a chimney with a flue diameter of, say, 6 feet (which is not uncommon), for in that event the Board would have sustained the Building Inspector for the same reasons, and six times $33\frac{1}{3}$ would have required a chimney 200 feet high.

Mr. Milton Dyer, in a letter dated March 21, 1906, in part states:

"The height of the chimney flue must be $33\frac{1}{3}$ times the diameter of the flue. This we, together with our engineer, find to be ridiculously high, and absolutely unnecessary, and certainly we do not intend to build it so high."

Mr. Dyer was sensible, and I must say that I never considered this feature of the Code.

The Building Code limited (unjustly) the spans of different types of construction, and on April 7, 1906, the Board of Appeals, in the case of the Wells Fargo Express Co., whose architects,

Richardson & Watts, wanted to place reinforced concrete girders 43 feet long in a stable, stated as follows:

"The Board, upon full consideration of the appeal, is of the opinion that the Inspector of Buildings properly refused the permit. However, the Board is also of the opinion that where such special construction is contemplated, and the proposed work is designed properly, such structures should be allowed if the public interests can be properly protected; and the Inspector of Buildings is, therefore, directed to permit such construction, provided the interested parties will enter into an agreement to properly safeguard such public interests by test or otherwise, as may be required by the Inspector of Buildings."

The Euclid Avenue Christian Church is a fourth class, first grade, Div. D building. Title 17 calls for metal lath and plaster in this class of construction, yet the Board of Appeals, on April 7, 1906, ruled as follows:

"The Board, upon full consideration of the appeal, is of the opinion that a building of the class contemplated in the above referred to structure, when the distance from the auditorium floor to the ceiling and walls is such that there can be no possible danger from fire being communicated to said ceiling and wall, the use of metallic lath will be unnecessary as a fire protection."

Again it appears the Board used discretionary powers, though these cases were clear and distinct and were not based upon any ambiguity in the wording of the Code.

From time to time the city has sold old frame buildings (in the fire limits) for the purpose of acquiring the property for park or other purposes.

In such cases the houses were moved from one portion of the inner fire limits to another, permits being granted by the city contrary to Section 809 of its own Code.

On Oct. 6, 1906, the Realty Trust Company appealed from the decision of the Inspector refusing to grant a permit for moving a frame building within the fire limits. This is what the Board of Appeals said in part:

"The Board of Appeals is of the opinion, and does rule that the Inspector of Buildings correctly refused a permit for the placing of a frame building within the fire limits."

The Board of Education, in its submitted design, showed the use of wooden roof boards for Glenville High School.

I refused the permit because—

Section 855 says that a building of Div. C of the first grade (school buildings), over one story and a basement high, shall be First, Second and Third Class construction (fireproof).

Section 561 states—

"In cases where a better class of construction is used in the lower part of the building, the height and area of such building shall be limited according to the classification of the uppermost story or *roof*."

Therefore, the roof being wooden, the building takes such

classification and becomes Fourth, Fifth, Sixth or Seventh Class, any of which are not Fireproof Classes.

Section 317 and also Title 26 fully describe Fireproof Construction as called for in Section 855 for School Buildings, and the use of wood is prohibited excepting for door and window trim, bases, etc.

But the Board of Appeals overruled me and authorized me to grant the permit under Section 522, which in part states as follows:

"The term 'fireproof construction' shall apply to all buildings in which all parts that carry weights or resist strains are made of incombustible materials."

Roof boards, though distributing the slate and snow loads, were not considered as carrying weights or resisting strains.

This point is open for discussion, but I consider Glenville High School not strictly a fireproof structure.

Some time in April, 1910, the old Leader Building on the south side of Superior avenue, next to the American House, was leased to E. F. Glass by the Koblitz Brothers, owners. The local inspector later reported that the lessee was partitioning off bedrooms, many of which had no outside light or ventilation, etc. The Building Department stopped this work, after which the lessee asked for a permit to continue and this being refused because proper plans were not submitted, the case was carried to the Board of Appeals.

The Building Inspector claimed his right to stop work and refuse a permit on the following:

Section 858 in part says:

"Every building hereafter erected or *enlarged* as a hotel for the accommodation of transient guests, and containing more than fifty sleeping rooms above the first floor, shall be of First, Second or Third Class construction.

"Buildings containing less than fifty sleeping rooms above the first floor shall be governed by the regulations prescribed for the construction of Tenements."

Tenement construction calls for brick enclosed stairways and halls, states maximum and minimum dimensions of rooms and windows, toilet and water supply regulations, double floors and other features.

The building in question contains none of these features, is four stories high, of Sixth Class construction, and a fire trap.

The owner and lessee claimed that under Section 220 they did not require a permit, since when putting in ordinary partitions they were not involving "any change in supporting members or structural parts, or in the stairways, etc."

They also claimed that under Section 326 they were not making a change of grade, since the building, as it was, was a store building on the first floor (Div. C, Second Grade) and for light manufacturing on the other floors (Div. E, Second Grade) and when this building became a lodging house, it would still be in the same grade but Div. A.

Section 326.—Alterations and Change of Occupancy.

"When a building or any part thereof, the use, or intended use of which brings it within any of the above mentioned grades is to be applied to, or altered for, the use of any other grade—for which a better class of construction is called for under the Code, the construction and equipment of such building must be made to conform with the requirements of this Code as specified for its intended use; and it shall be unlawful to so alter or occupy any building without having secured a permit therefor from the Department of Buildings."

The Appeal meeting was heard on April 14, 1910, and ruled in part as follows:

"The Building Inspector, in refusing to grant permit to parties desiring to use the upper floors of the old Leader Building for Lodgings is sustained.

"Motion carried unanimously.

"An amendment was made to this motion instructing the Building Inspector to write to the parties desiring to make this change, stating that as they were making no alterations in the building (in conflict with Section 220) no permit was necessary, and that under Section 326 of the Code they would be guilty of no violation until said building was actually occupied as a lodging house."

In other words, on the hypothesis that a stable is not a stable until there is a horse in it, no violation existed until the lodgers were housed.

When this occurred, on the advice of the Law Department, arrests were made twice on both owner and lessee, but the courts dismissed the case and the building, when I left office, was one of the worst conditions of this sort in the city.

Also, with the Board of Appeals ruling on this case, substantiated by the verdict of the court, there is little to prevent the change of a factory building to a lodging house, since there would be no change of grade (both being in the Second Grade) and minor alterations, such as partitioning off, would require no permit.

The following give a brief outline of Sections in the Code which appear to conflict, and in any case are worded in so doubtful a manner as to cause endless controversy and Board of Appeals cases, which at best are not a satisfactory solution, since, as shown, the Board of Appeals is not infallible, and as the records show, in some cases it has declared itself unable to use discretionary judgment no matter how meritorious the case, while in others, though sustaining the Building Inspector's decision, has authorized him to grant permit for conditions in violation of the Code.

Attention is also drawn to manifestly impossible conditions to enforce.

Section 198.—No awning is allowed whose frame is less than 7 feet above the sidewalk.

Sections 1002 and 1033 allow a minimum of 8 feet.

Section 200 appears satisfied if final tests on gas piping are made in the presence of the Inspector of Heating.

Sections 520 and 969 state these tests must be made under the direction of the Inspector of Buildings.

Section 202 calls for a permit for the repair of any building.

Section 220.—Permits not required for minor interior repairs.

Section 208 calls for scaled drawings of situation plan (wholly unnecessary and not always best).

Sections 210-213 call for all drawings to show the location of plumbing pipes, electric wiring, heating pipes, etc., and all openings larger than 3 inches square in fireproof floor construction.

Section 217 calls for all specifications to be grouped in the order of their construction, and they must be indexed.

Sections 219, 220, 267 and 326 state that the Building Inspector shall be notified or a permit obtained when any work is done changing the classification or grade of occupancy of any building.

Important and drastic changes could be made without violating these Sections, since a factory and a hotel are in the same grade (second grade); so also are a police station and a church (first grade).

Section 222 states that plumbing plans should be submitted by the Board of Health to the Inspector of Buildings for his stamp of approval, after which they are returned to the Board of Health. (This is not advisable.)

Section 230 states that plans shall be prepared to 1/16 scale for permanent file of all Public Buildings, Schools, Theatres, Picture Shows or Minor Theatres, Hotels and Office Buildings. (It does not state who prepares these plans, nor is there provision made to store same.)

Section 231 states original plans and specifications of applicants for a permit shall be returned within three working days from the time of filing same. (You who have waited know how this is enforced because of insufficient staff.)

Section 232 does not allow permit to be given for a stable before proper arrangements are made for drainage, sewerage and water supply.

Section 807 only requires provision for drainage to a sewer when more than four animals are to be housed.

Section 236 calls for a final inspection of all buildings except Dwellings, Stables and Sheds, by the Building Inspector. The owner is to notify the Inspector when the building is ready for this inspection, and the Inspector is to issue a certificate to the owner if the building complies with all the provisions of the Code.

(Because of lack of staff, etc., this cannot be done.)

Section 238 calls for tagging buildings with metal tags, a duplicate tag to be sent to the City Auditor.

(This is not done, nor can it be.)

Section 240 provides for two notices in writing to the owner or his agents before stopping work or revoking a permit. (This should be changed; two notices might take four days.)

(This section is the same as Section 1119.)

Sections 241 and 1120 impose a penalty for violation.

Section 241 includes those who are employed to assist in such violation, also all persons or corporations.

Section 1120 includes those who are employed or assist, and does not include corporations.

Section 251.—No building can be moved except by a licensed mover. (Small sheds are often moved by the owners, and this should be allowed.)

Section 264 states that any additional provisions recommended by the Board of Appeals should be reported in the annual or semi-annual reports of the Department of Buildings to the City Council for amendment.

(Six months or a year is too long to wait for an addition or correction needed.)

Section 274 defines "Building Line" as the outer face of the enclosing walls of a building and surface of the ground.

(In a Board of Appeals case this definition was criticized. The lot line might also be the building line, or, all ambiguity should be cleared by defining "the Line of the Building" rather than the "Building Line".)

Section 277 defines an Interior Lot as one fronting on but one street line, and the remaining sides bounded by lot lines.

(A public thoroughfare less than 30 feet wide (29 feet 11 inches) is, by Section 266, an alley, but no allowance is made for this advantageous condition should this alley abut the rear of an interior lot.)

Section 280 defines courts, and has caused endless confusion. An Inner Court is a court surrounded on all sides by walls.

An Interior Court is a court open to a lot line, but when the adjoining owner builds on the lot line with a dead wall the Interior Court becomes an Inner Court and is only one-half the size required. There are similar objections referring to other court definitions, but the space of this paper will not allow lengthy discussion.

Section 280 defines a court as a space free, open and unobstructed by appendages from the ground to the sky.

Section 813, under certain limitations, allows one-story sheds to extend 25 per cent into the space reserved for courts.

(If this is allowed, the entire court could not be regulated from the ground to the sky, but only from a possible three-fourths of the ground.)

Section 313.—Division Wall.—“The bearing wall running from front to rear sub-dividing a building into several parts.” Party Wall.—“A wall that separates two or more buildings, and is used, or is to be used, jointly by said separate buildings.”

Section 434.—Except in the case of Seventh Class building, a party wall shall never be less than one and one-half brick.

Section 402.—Table A gives the thickness, etc., of bearing, fire and party walls, for *all* buildings from First to Sixth Class, and allows a party, bearing or fire wall one brick thick.

Section 587 allows “Brick Division” or “Party Walls” for dwellings of the Seventh Class, as fire walls when spaced not over 40 feet.

Such wall to be one brick thick and carried through roof.

Section 586.—Brick Division Walls.

“If brick is used for fireproofing between studding, the division walls may be plastered on wood lath with lime mortar.”

Section 819.—Tenements of Sixth Class construction must have every suite of two apartments separated by fire or party walls one and one-half brick thick.

Section 522.—The term “Fireproof Construction” applies to buildings in which all parts that carry weights, or resist strains, are made of incombustible materials, or if not possessed of these qualities these parts shall be covered and protected by fireproof material.

Section 524.—Fire and waterproof materials are:—

Brick, Terra Cotta, Concrete, Metal Lath and Plaster.

(A building with wooden parts and beams, covered with metal lath and plaster, under Section 522, would be of fireproof construction, though not according to Section 317 and Title 16.)

Section 329.—No sixth class building can be over four stories or 60 feet high.

Section 576.—Sixth Class buildings may be five stories or 70 feet, if floors are doubled, etc.

Section 328.—The limitations in height for Seventh Class buildings are 40 feet, 32 feet, and when without finished interior, by Section 583, 25 feet. Nor shall any roof appendage (except in churches) exceed 15 feet above the roof, and never over 55 feet above grade.

Section 671.—A Seventh Class tower may be 70 feet high, but must not exceed a base area of 1,600 square feet. If the area of such tower exceeds 100 square feet, its supports shall be carried to the ground.

Sections 332 and 333.—*No* building of the *Third* Class shall exceed ten stories, or 125 feet, and *no* building of the *Second* Class shall exceed twelve stories, or 150 feet.

Section 558.—*Any* building of the *Second* or *Third* Class may be carried up to the height of the next class above if certain conditions are carried out.

Under the above exception, it is better for the owner, when intending to build a building 200 feet high, to obtain his permit under Section 558, for a Second Class building, carried up to the height of a First.

Section 347.—Concrete footings are specified as one, three and five.

Section 448.—Reinforced concrete work for buildings, one, two and four.

(In Section 347, the words "not reinforced" should be inserted.)

Section 388.—Brick footing of all buildings except Sixth Class, not less than two courses thick and 8 inches wider than walls, by Section 389, if concrete is used, concrete shall be not less than 12 inches thick.

(This discourages the use of concrete footings.)

Also Section 361 allows a load of three tons per square foot on compact sand. (Some walls, when loaded, would not cause more than two tons per square foot pressure. Why any footings?)

Section 442 calls for parapet walls for all exterior, division and party walls over 15 feet high.

(No allowance is made for fireproof roof construction, which often does not require a parapet wall.)

Section 466, 459 and others regulate the allowable stresses on steel and concrete.

Section 367.—"No joist, beam or rafter shall exceed twenty times its depth in length." (Why not?)

Section 513 refers to single dwelling occupied by one family.

Section 322 defines a Dwelling as the home of two separate and distinct families. Section 584 refers to a double dwelling as containing more than two families.

Section 576 calls for a dead brick wall on the line of an inner court, if said court is not built of masonry.

(This action would change the inner court to an interior court and be in violation of Section 735.)

Section 566.—"The use of wood furring or of stud partitions shall not be allowed in buildings of this class (Fourth Class). Sub-dividing partitions may be the same as prescribed in Section 571—"Incombustible stud partitions allowed".

Section 294.—Incombustible stud partition, one plastered on both sides on metal lath, and fire stopped top and bottom between studs "at the ceiling and 8 inches from the bottom".

Section 580.—By this section, in Title "Frame Buildings", such building, 30 feet high by 99 feet long, would have to be 8 feet from the lot line.

Section 737, of Title 29, which title refers to "*all buildings*", the above distance would be 3 feet 6 inches.

(It was intended parts of Title 29 should not refer to frame buildings, but it does not say so.)

Section 578.—"It shall *not be lawful* to erect *any* frame building *greater than 2,800 square feet* on an interior lot unless sub-divided by fire walls." This section refers you to Table G for other dimensions of frame buildings.

Section 760.—*Any* building not over two stories high may have 50 per cent increase over the areas of Table G.

Section 759.—Table G gives the maximum area between fire walls for all classes of buildings *over* two stories high when occupied on all floors by stores, salesrooms, warehouses, workshops and factories.

Section 760 allows a frame building in an interior lot of 4,200 square feet, for it states—*Any* building not over two stories high may have the areas of Table G increased 50 per cent.

Section 820, referring to frame Tenements, which are frame buildings, only allows 1,200 *square feet* between fire walls.

Section 634.—The minimum width of stairs is 3 feet. Section 643 calls for 3 feet 6 inches as a minimum width, and an increment of increase of 6 inches, for certain conditions. These conditions are for all buildings of the First, Second and Third Grades.

Section 654 gives the following minimum widths: First Grade, 4 feet; Second Grade, 3 feet 6 inches; Third Grade, 3 feet.

Section 637.—The construction of *all* stairs shall conform to the class of building in which they are placed.

Section 677.—Outside stairs used in connection with porches attached to buildings of the Fourth, Fifth and Sixth Classes, over two stories high, but not more than four, shall be of at least *Fifth Class* (mill construction).

(This is hardly in keeping with Section 637.)

Section 917. The stairways of all Assembly Halls, seating more than 500, shall be built entirely fireproof.

(An Assembly Hall, seating 750, by the provisions of Section 870, could be a Seventh Class (frame) building. Here we have a fireproof stair called for in a frame building, a good provision, but a conflict with the following: "The construction of *all* stairs shall conform to the class of building in which they are placed." (Class meaning construction.)

Section 644 regulates the number of stairs according to occupancy of lot.

5,000 to 7,500 square feet equals two continuous lines of stairs.

7,500 to 12,500 square feet equals three continuous lines of stairs.

Greater than 15,000 square feet, the number of stairs shall be increased proportionally. (Proportionally to what?)

Section 645.—"If there are more than 16 rooms above the second floor, etc." (The above might mean the third floor.)

Section 655.—*All* entrance halls passing through a first floor occupied for mercantile, etc., purposes, shall be enclosed *entirely* with fireproof walls.—In non-fireproof buildings such enclosures shall be of brick from foundation to *top* level of *second* tier of beams.

Sections 823 and 824.—For Tenements, calls for brick enclosures *throughout*.

Section 660.—Buildings erected or altered in the fire limits cannot have shingled roofs. Section 790 provides these conditions only when the building is higher than one story.

Section 670.—"All buildings shall be kept provided with proper metallic down spouts." (This cannot be enforced.)

Section 673.—All wooden tanks hereafter erected on buildings in the fire limits shall be enclosed in brick or other incombustible material.

(Never enforced for obvious reasons.)

Section 677.—All porches over two stories high shall be of mill construction with iron frames, and fireproof construction if over 60 feet.

(Why should the construction of an outside porch be better than the building?)

Section 732 allows 95 per cent of a corner lot occupancy. Example: Lot 50x140=7,000 square feet. 95 per cent leaves yard 7 feet.

Section 743.—No yard shall be less than 10 feet (in a corner lot) for *any* building.

Section 732 allows 90 per cent of an interior lot.

Section 742.—Yard must be 10 feet (for 40-foot height), etc.

Lot 50x140=7,000 square feet. 90 per cent leaves yard 14 feet.

Section 736.—Relating to courts. *Depth* means horizontal *length*; in the last part of this section the words *length* and *depth* are used when they mean the same thing, *length*. (These ambiguities are found in Sections 737 and 738.)

Section 755.—Any building of First, Second, Third and Fourth Grades, may be built facing an alley if it is at least 30 feet from opposite side.

Section 753.—An alley shall be deemed a court, but measurements for courts shall be taken 8 feet from the opposite side.

(How high a building can be built facing a 20-foot wide alley?)

Section 735. Table F, Column 6, for windows on one side only, for a court 20 feet, less 8 feet=12 feet. Answer, an eight-story building of a maximum height of 120 feet.

Section 335.—"No building shall be of a height exceeding two and one-half times the width of the widest street upon which it faces."

(This provision does not apply to alleys, but why?)

Section 732.—*No* building of the First and *Second* Grades shall occupy more than 95 per cent of a corner lot or site.

Section 757.—Buildings of Div. C and D of the *Second* Grade may cover the *entire corner lot* for such floors as are used for store or salesroom purposes.

Section 805.—When width of stable is less than 80 per cent the width of lot, yard behind stable can be 3 feet.

Section 742.—Behind every building a yard space of 10 feet.

Section 819 (b) refers to Cellars or Basements. (They are not alike.)

Section 278.—Cellar, not suitable for habitation.

Section 271.—Basement, suitable for business or habitation.

Section 823 calls for stair hall enclosures of *solid* masonry for non-fireproof tenements.

Section 364 allows *hollow* tile blocks for enclosing walls.

Section 873 regulates minor theatres, limiting the size of stage, scenery, curtain, etc.

Section 940 calls for 8-foot courtways on each side, balcony emergency stairs and other features.

Ordinance 10924, regulating moving picture show rooms, allows stage and balcony without limit and only requires one 6-foot court-way on one side.

Section 855 (a), referring to certain construction, states: "Shall be built *fireproof* of either First, Second, Third or Fourth Class construction."

Section 317 calls a Fourth Class building "semi-fireproof or composite".

Section 940 (b) calls for a proscenium wall of brick when seating capacity is over 500; for less than 500 (or 499 people) said wall may be of incombustible material 4 inches thick.

No mention, or requirement for a fireproof curtain (which opening is 75 per cent of the wall). This curtain is not required until we get 750 people or over.

(What is the use of a solid brick proscenium wall with a hole (75 per cent of it) covered with a muslin curtain?)

Section 944.—A gasoline tank of 250 gallons or less must be 25 feet from any building or lot line. Such tanks, if they are enclosed in pits 6 feet distant, may be one-third this distance nearer to building or lot line, provided "that no such tank shall be located at a less distance than 25 feet from any other building." (This conflicts itself.)

Section 997 calls for lanterns to be displayed and maintained where building, etc., is going on in public property.

(It does not say they shall be lighted.)

Section 864.—Factories and Workshops.—

"All *factory* and *workshop* buildings over two stories in height hereafter *erected* or *altered*, shall be of fireproof, semi-fireproof or mill construction throughout."—(This Section apparently applies to a newly erected factory building, or an existing factory building increased in height, but its wording is ambiguous for a case where a three-story office building of Sixth Class construction was increased to five stories, as allowed by Section 576 (d), and then occupied for light factory purposes, for Section 576 (d) allows Sixth Class building (without reference to grade) to be increased to six stories or 70 feet, while Section 329 says: "No Sixth Class building can be over four stories or 60 feet high.")

Referring to Tables A and B:—

Section 402.—"Table A gives the thickness, heights and lengths of external and internal bearing, fire and party walls from First to Sixth Class, not over four stories and a basement high, with the first story not exceeding 12 feet in height."

(Nothing said about basement height.)

Section 404.—"Table B gives the thickness and heights of all external and internal bearing, fire and party walls for *buildings* from one to sixteen stories high" with the first story limited to 18 feet and the basement to 12 feet.

(Nothing said about class of building until you read Section 416.)

Taking a floor load of 50 pounds, walls up to 100 feet long and building four stories:

Under Table A, the following is required:

Basement, 16-inch wall.

First story, 12-inch wall.

Second story, 12-inch wall.

Third story, 12-inch wall.

Fourth story, 8-inch wall.

Attic and Coping, 8-inch wall.

Coping, 2 feet above roof.

Under Table B, for the same condition:

Basement, 20-inch wall.

First story, 16-inch wall.

Second story, 16-inch wall.

Third story, 12-inch wall.

Fourth story, 12-inch wall.

Attic and Coping, 12-inch wall.

Coping, 3 feet above roof.

(There is a decided advantage in using Table A.)

There are discrepancies in Tables A, B, C, D and E, which the space of this paper will not permit of discussion. This feature can be taken up later when a revision of the Code takes place, as it surely will, sooner or later.

(Section 416 states that Table B shall be used for all buildings of the First and Second Grades, but why impose more severe restrictions on a four-story warehouse, factory or workshop building under Table B, than is imposed under Table A for a four-story Tenement and Apartment house?)

Table E "gives thicknesses, heights and lengths for walls of variable section, or walls stepped off in offsets."

Walls 90 feet high and spaced over 75 feet center to center by this table would be stepped off in five sections as follows:

First section, 25 feet high, $5\frac{1}{2}$ bricks thick.

Second section, 20 feet high, 5 bricks thick.

Third section, 15 feet high, $4\frac{1}{2}$ bricks thick.

Fourth section, 15 feet high, 4 bricks thick.

Top section, 15 feet high, $3\frac{1}{2}$ bricks thick.

But Table D for walls of one thickness gives the following for the same example:

Any wall, 75 to 90 feet high, over 75 feet center to center, need only be five bricks thick.

(It appears cheaper to build a wall of uniform section, though it is not better.)

Section 620.—Steam and hot water pipes are allowed as close as 2 inches to any unprotected woodwork, and as close as $\frac{1}{2}$ inch when such woodwork is protected by a metal shield. (Nothing said about quality of shield.)

Section 621.—When such pipes are enclosed in wood casings, these casings shall be lined with metal, or else said pipes shall be covered with incombustible pipe covering, $\frac{3}{4}$ inch thick.

Section 563.—In fireproof buildings all heating pipes, etc., when enclosed, shall be encased in separate fireproof ducts, etc.

Section 502.—Whenever steam, water, plumbing or other pipes which might cause condensation or irregular variations of temperature *are enclosed* and adjoin any member of an iron or steel frame, the iron members shall have all external air spaces—filled solidly with 2 inches of concrete extending 2 inches beyond the extreme edges of the flanges, and (Section 620) the pipes shall be covered with at least $\frac{3}{4}$ inch of incombustible pipe covering.

(One can readily see the too stringent regulation for fireproof buildings and the too lax provision for the other building.)

Section 998.—A permanent showcase, if used solely for the exhibition of wares of the occupant of the premises, may extend upon public property, where the sidewalk is at least 15 feet wide, a maximum of $2\frac{1}{2}$ feet.

Section 1003.—Any bay, oriel or balcony may extend into public property as follows:

Bays or oriels, 3 per cent (the width of public space), but not more than 3 feet.

Balconies, 5 per cent (the width of public space), but not more than 3 feet.

Section 1001.—After the passage of this Code *no* fixed or permanent store fronts, showcases or show windows (any projecting oriel or bay in any story, constructed for the display or advertisement of goods or wares—

shall be deemed a show window shall be constructed so as to project beyond the street line.

Section 1032.—“A marquee, or fixed awning, projecting over the street line, may be erected over entrances of any business front, or along the whole of a store or shop front *for the purpose of better lighting the interior*.”

“All fixed awnings shall be made on metal frames and covered with sheet metal roofs, or if covered with glass it shall be $\frac{1}{4}$ -inch wire or prism glass, not exceeding 16 square inches in area.”

(Where the first part of the section only allows a marquee or fixed awning “*for the purpose of better lighting the interior*”, it seems inconsistent to say they shall be “*covered with sheet metal roofs*”.)

Section 1035.—Fireproof porticos, not over one story high, built entirely of iron or steel frame work (or covered as prescribed) for a marquee in Section 1032, may be built over the sidewalk in front of the main entrance of any assembly hall, theater, hotel, railroad station or department store *of over 60 feet frontage*, but such portico shall not exceed more than 4 feet beyond each side of the entrance doors.

(By the very stipulated construction of a marquee, viz.: Metal frame and sheet metal or glass roof, it all depends on the way the Building Inspector feels when he grants a permit; a portico might be considered a marquee, and be erected of unlimited frontage, or as a portico, not more than one-third the frontage, or 4 feet beyond each side of the entrance.)

Section 1042.—Buildings requiring fire escapes.

(1) Every non-fireproof building occupied by one or more families above the *second floor*.

(2) Every non-fireproof hotel or lodging house having more than five sleeping rooms above the *second story*.

(3) Every non-fireproof factory, mill, manufactory or other building, three or more stories in height, where ten or more persons are to be employed above the *second floor*.

(4) Every non-fireproof public or private hospital, asylum or school house—more than *two stories* high.

(5) Every building, whether fireproof or non-fireproof, occupied, as in cases 1, 2, 3 and 4, having but one staircase and being three or more stories in height.

(How about cases 1, 2, 3 and 4, which require fire escapes, without mentioning the number of staircases—should these be cases where two or more staircases were in use?)

(Also note cases 1, 3, 4 and 5, referring to floors in height; case 2 refers to story, viz.: Above the second story; is this the third floor, or on top of second floor?)

Section 1041.—Buildings not requiring fire escapes.

(1) Section 651.—All buildings where one incombustible stairway, of every two stairways required, is on the outside of the building, or where the stairway is enclosed and entrance thereto on any floor is from an incombustible balcony or loggia, free and open on the outside to the air.

(2) All hotels, schools, hospitals, detention buildings, office buildings, tenements, apartments, club buildings, of fireproof construction, having two stairways, one of which is enclosed—and leading directly to the ground floor.

(3) All fireproof buildings having two or more stairways (nothing said about their being enclosed) containing nothing of a hazardous risk—under the rules of the Fire Department.

(4) Dwellings not over three stories high.

(Items 1 and 5 for buildings requiring fire escapes, viz.: Every non-fireproof building occupied by one or more families above the *second floor*, and every building of whatever class as in 1, 2, 3 and 4, three or more stories in height, having but one staircase, apparently conflicts with Item (4), buildings not requiring fire escapes, viz.: Dwellings not over three stories high.)

(Also the words “floor” and “story” are used in a confusing manner.)

(No one has defined how many people might constitute a family.)

(Also, three-story dwellings are exempt.)

Section 322 allows two families living separately and distinctly in a dwelling; it also allows fifteen sleeping rooms for boarders, and it allows two or more such dwellings to be connected on each story, provided the halls and stairs are not altered.

With four boarders to a room and twelve members to each family we have a possible three-story frame building containing 84 persons in sleeping quarters, which, by Section 1041, Item 4, and Section 322, does not require a fire escape.)

In a letter dated October 31, 1911, the Law Department wrote three pages, trying to explain the above ambiguities. In part, the letter states: "In arriving at the meaning of the Council in this Section." "From examination it is my opinion." "I believe it was its intention." "In order to cover the intent of the Council." And so on.

In a recent case before Judge Collister on the "Knickerbocker Sign", the court ruled out any testimony leaning upon the *intent* of the Section in question, and stated that it would give its decision on the "*reading of the Section or Law*". This reasoning, applied to Sections 1041 and 1042 would make their literal enforcement impossible as written.

It is impossible within the scope of this paper to quote such sections, as, by the nature of their requirements, rightfully belong to the Police or Fire Departments, but in a general way, the following conditions exist:

Fifteen Sections of the administrative portion are no longer legal owing to the changed form of City Government.

Seventy Sections contradict each other, or are so ambiguous as to be non-enforcible.

Twenty-three Sections relating to billboards cannot be enforced.

Twenty-five Sections are in the wrong portion of the Code, causing confusions and violations.

Eighteen Sections, regulating light and ventilation, should be re-worded, tabulated and made easier of enforcement.

Sixty Sections contain fire warden's duties.

Thirty-five Sections refer to the Department of the Director of Public Service.

Ten Sections are impossible because of misprints and errors.

While opinions may differ on the questions taken up by this paper, *the very fact that they are open to argument* is sufficient to show *the necessity of re-arranging and re-wording the Code*.

A better worded and smaller Code, entirely enforced by a well organized Building Department, would be an improvement on the present conditions, where only portions of the Code are enforced, in a spasmodic manner, with different degrees of severity by different Building Inspectors and always with an insufficient staff. As it is, one is reminded of the tail wagging the dog; the Building Code is wagging the Building Department.

And further—when we stop to consider that the Post Office, Court House, Locomotive Engineers' Building, Union Club, Sterling & Welch Building, the Y. M. C. A., Statler Hotel and other excellent structures recently erected are in violation of the Building Code in one or more features, and that under a strict inter-

pretation of the Building Code it would be impossible to duplicate such excellent structures as the Rockefeller, Schofield, Rose, Williamson and Guardian Trust Buildings, is it not time to give the Building Code a more careful study, by a committee of Engineers, Architects and Builders, and adopt such changes as they may suggest?

Sept. 10, 1912.

Discussion

MR. ALLEN:—

Of course, it is self-evident to any one handling the Building Code that there are many things in it which require improvement. Since I have been Inspector of Buildings I have made a good many improvements in the Code, and some of the things Mr. Marani brought up tonight have been taken care of, and others are on the way. I am very glad, indeed, that the Engineering Society has made Mr. Marani Chairman of the Building Code Committee, because it will make it possible for him to give the Department of Buildings the benefit of his experience in helping correct these faulty sections he has called attention to. It is my intention when changing the Code where there might be some serious thought required; that is, where it is something more than straightening out ambiguous language, to send a notice of the proposed changes to this Society and to the American Institute of Architects. I am asking their committees to have joint meetings, or separate meetings, if more convenient, and make suggestions as they may see fit.

It seems to me that what the Code needs primarily is rearrangement. It needs to have many sections broken up and subject matter which is scattered through the book brought together, and it should then be so published that those parts belonging to certain trades or professions would be brought within the reach of those trades or professions.

I have been very much interested in Mr. Marani's paper. I should be very glad to have a copy of the sections referred to where conflicts occur. I am trying to do something along the lines which Mr. Marani followed for bettering the conditions complained of. I have had people come in and tear their hair over some part of the Code, then I say to them, "You have evidently given a great deal of thought to this matter. I would be glad to have your suggestions for revision of the section." Up to the present time I have received no revision of any section.

MR. EMERSON:—

I think that almost every one will agree that it is a very difficult thing to write a set of specifications for a single building of any size, in which, before the building is completed, there will

not be discovered more than one section which it would be impractical to interpret literally, and sections which it would be impossible to carry out.

If such difficulty is experienced in writing a set of specifications for a single building, to be erected under known conditions for a definite purpose, is it any wonder that defects should be found in the building code, which has to cover all buildings from the smallest to the largest, from the cheapest construction to the best, and for all purposes, from the most common to the most unusual?

On the other hand, is it not more surprising that in spite of the advances in building construction and the work done in other cities along this line, to say nothing of the profanity and abuse hurled at it locally, that the larger portion of the building code remains today exactly as it was written nearly a decade ago?

During this period the advances in our knowledge of the engineering features of buildings, both structural and fire protective, has been very great. However, the greatest opportunities for improving the code lie not in adding to it but in cutting out much of what is there at present in the form of purely empirical rules or too detailed specifications and substituting broad engineering principles.

There is also great room for improving the arrangement of the code without in any way changing its sense, and also the index could be greatly improved.

Despite these defects, however, the building code has served its purpose well and has been of great benefit to every one connected with the building industry, including the owner, the architect or engineer, and the contractor. But when all is said and done the value of any code depends not so much on what it contains in its pages as upon the ability, common sense, and efficiency of the department engaged in its enforcement.

MR. BLASER:—

I will read part of a section that I came across today, to illustrate the fact that the Code is not clear in many points. This is in Section 411. I marked it because it came up in connection with the design of a certain building: It reads as follows:

“When the height of any story is increased one-half ($\frac{1}{2}$) brick shall be added to that story and all walls below for every succeeding interval of fourteen (14) feet or part thereof increased to the height of any story up to seven (7) feet, or, when the whole of the fourteen (14) feet distributed equally in not less than two (2) stories, provided, that no story shall have its height increased beyond sixteen (16) times the thickness of its enclosing walls at the base without a still further increase of thickness, nor shall the total height of walls exceed the maximum limits established for any class or grade of building.”

A conglomeration of words. I do not suppose any man here could explain the meaning of this section. I have been trying to find out ever since I first read it what it intended to say.

I must confess, having worked under the Code for some years, that I do not always know now under what class or grade

of building I am working. For example: Title II classifies concrete buildings as third-class. Title XVI puts them under fourth class as far as height is concerned, etc., etc. It seems to me the Code could state clearly the class or grade of a building, and I would be glad to have Mr. Marani, in summing up, tell us if this could not be made plainer.

There are certain other features of the Code that are not very plain. This is true of the Concrete Code. I agree with what Mr. Emerson says as to the difficulty of writing specifications for a single building and that we should appreciate the far greater difficulty of writing sections which would govern construction of buildings in general. The Code goes too much into detail. It should lay down broad, general lines which an engineer is supposed to follow. This, if the wording were clear, would avoid a great deal of the trouble in getting permits. I am sure we all intend to follow the Code, if it were only possible to know what it intends to say. We should revise sections, however, whenever experience shows that a revision is necessary.

MR. HENDERER:

The only thing that I have to say about the Code is that the more I see of the present Building Code, the more I am confirmed in the opinion that it goes too much into detail. I believe the Code should lay down general conditions and then give the Building Department authority to interpret and pass on the different points as they come up from time to time.

In my opinion, it is impracticable to write a general detailed specification that will apply to every class of structure that is being or may be erected in the city of Cleveland. Each structure is a problem in itself and should be treated individually as such.

MR. HAMMOND:—

I am not authorized to speak for anybody except myself, and I wish to have that thoroughly understood. I am not speaking for any building which I have built, am building, or expect to build, nor for any person or corporation, neither am I speaking for any expected benefit to myself. I have been erecting buildings in this city for years. I have seen Cleveland gradually increase in size and in the better class of buildings, and we all got along first rate, everybody seemed to be pretty happy, architects could prepare plans which certainly seemed to show some intelligence, engineers were able to construct anything that they were called upon to construct; but all of a sudden it seemed to be discovered that something was wrong, nothing was good enough, nothing was right; we all seemed to be in great need of a dose of paregoric, which was administered to us by way of introducing new rules and regulations for the erection of buildings, and finally the city of Cleveland was honored by the birth of the new Building Code and everybody was delighted. (Laughter.) Cleveland seemed to be getting along nicely, but after a very short time it

was discovered that there were some defects in the Code. Some thought that it was cross-eyed; others thought it had the rickets. Cleveland was congratulated that it did not happen to be twins. (Laughter.)

There are so many good points about the Building Code just as it is now that it is a pity there are so many bad features, and it seems as if it would be such a very simple thing to remove the bad features and retain the good.

Now, as I never asked or desired any city or county position, there certainly cannot be anything of a personal nature in what I may say about this Code, but among all the books on these shelves it would be hard to find anything so blind or unintelligible as is the Cleveland Building Code, and yet it would not entail a great deal of work to take a pair of scissors and a paste pot (which probably helped construct it) and re-arrange the Code. It is not necessary for it to be a text book, neither is it necessary to teach architects and engineers how a building should be built. They are supposed to know something about that before they start at all. There are a great many parts of the Cleveland Building Code which would make a good text book, but they are not in the form a text book should be. When you read some of the sections you think possibly you could do "so and so", then after you read it again you think you have possibly got it wrong—and you probably have. A person should have ten fingers on each hand to keep track of the cross-references. I have built in many cities; I have not had any difficulty in getting building permits; at the same time I can see that the Building Code we have, if re-written, could be made much more presentable than at present. For instance, the Hotel Belmont, New York, costing four to ~~five~~ million dollars, could not be built in the city of Cleveland under the Code; you could not build the Metropolitan Tower in Cleveland (even if only four stories high) because it would not comply with the Code. Of course, this is sanctified ground here; it is better than Boston or Philadelphia, yet I wonder why we should have a Building Code which is restrictive, and a preventative of building. It seems to me that it acts as a damper on the city of Cleveland, as it now exists. It could be made a satisfactory Code, but I claim that this whole Building Code today could be knocked higher than a cocked hat on account of certain clauses in it which are not just or right, and not founded on common law, and yet, it has a great many good features.

I prepared, in discussing the subject, a letter to find out what the general feeling is on our Code in its present condition. I sent it by a man whom I engaged, to see the different architects in this city. He reported that he found about 30 of them out, so he did not have an opportunity to show it to them. He came back with about 30 other architects' signatures. There were about 15 or 20 more, I should judge, who stated that the Cleveland Chapter of the American Institute of Architects had appointed a committee to consider this matter. I do not intend to do anything that will interfere with what they are doing. I am a fellow of the American Institute of Architects myself; I have been since '85 or '86. At the same time the Cleveland Building Code

is not for the American Institute of Architects. It is for all the owners, engineers, architects and builders in the city of Cleveland; consequently, the letter I have with the signatures is going to be presented to the Mayor of the City of Cleveland asking him to appoint a committee for rewriting the Code, and that an appropriation be made to pay for the same. A member of the Cleveland Chapter of the American Institute of Architects suggests that it might be a question of politics: "We might get another like it or perhaps worse." We could not get a worse one. (Laughter.)

I believe that this Code should be rewritten and I believe Mr. Marani has done excellent work along these lines. There is not much question about what steel construction ought to be. Of course, there is the difference between the two great classes of construction; reinforced concrete, and steel and there is always a question whether a building can be put up fourteen stories in the air, or ten stories; or whether reinforced concrete girders are as good as steel girders; but aside from these things, the engineers have a comparatively easy time. It is the architects who have the trouble because much of the Code is not easy to understand. I have seen men, perfectly conscientious men, trying to decipher or interpret certain provisions in that Code, and they have not been able to do it with the aid of first-class lawyers. Just as a gentleman here said, I defy anybody to read some of the sections in that Code and understand what they mean.

The question is, who should compose a commission for revising the Building Code? We want the suggestions of engineers, lawyers and architects. I was going to suggest it might be a good way to have the engineers in the city of Cleveland vote and request the Mayor to have one of their number appointed, and the architects to vote and request him to appoint one of their number; also the lawyers who are interested should be represented. Personally, I do not care a rap about this matter, because my work is mostly out of Cleveland, but it seems a pity that we are obliged to prepare plans to meet the requirements of a Code which is as blind as this Code is, and which asks for a class of buildings that are so much better than buildings in New York, Chicago, Philadelphia, or any other part of the United States. I say what is good enough for them is good enough for Cleveland.

Just one more word, I am not speaking for any individual, for any corporation, nor for myself as an architect; but merely as a citizen of Cleveland, who believes that the present Code is an imposition on the architects and owners of this city. Yet, it contains many good points, and an equal number of bad ones.

MR. ALLEN:—

Just one word in reply to Mr. Hammond's remarks. I cannot understand how the Cleveland Building Code is holding back building operations in Cleveland. I do know that we have issued this year nearly 450 more permits than were issued last year for the same period and that last year exceeded the previous year.

Building operations are increasing very steadily. I think Mr. Hammond should have come in long ago and helped straighten out this Code.

MR. VORCE:—

I came to listen, not to speak. I am rather interested in the portion of the paper which I heard, and I think perhaps some of the early experiences in administering the Building Code may be of interest.

This same discussion, perhaps not so acute as today, commenced about the first year of the operation of the Building Code—the original of the present Code. At that time we were pretty busy trying to look after all the duties imposed by the Code, with a force of four or five men. Wherever a section was found to be ambiguous, we prepared a revision and submitted it to the Council. We even went so far as to have special blanks prepared so that suggestions could be presented to the Department without difficulty. In all, we gave out something like 2,000 sheets. We received possibly half a dozen suggestions, three of which were adopted. In the two years' experience I had as Inspector of Buildings, that was all the response we had from those who objected to the Building Code. Now, even in the Bible we find conflicting passages, and it seems to me that in any effort which may be made to correct the Code, that the foremost thought should be the underlying principles of good construction, and the avoidance of all unsanitary building.

There are, as Mr. Marani pointed out, conflicting clauses. I have no doubt that if the sections he has mentioned were presented to the Building Department, they would receive very careful consideration. It seems to me that you ought always to bear in mind that you have something pretty good, and you should clarify it rather than build up a new law. When you try to put in new laws you will find in a few years that they are not adequate. They have to be brought up to date from time to time.

MR. MARANI:—

In reply to Mr. Allen I will state that it will give me pleasure to furnish him with a copy of this paper, and as I have always found him very pleasant I feel he will do all he can to assist us in the re-construction of the Building Code. Mr. Vorce was correct and ably expressed himself when he said that in any revision of the Code the good features must be retained and that any revision of the Code should contain regulations controlling the sane, safe and sanitary construction of buildings.

That is exactly what a Building Code revision aims to do, and this can be done with less Code (a smaller Code); a Code of conditions, not specifications; a Code with fewer references, no ambiguities and containing only building regulations; not, as is the case in the present Code, containing police, fire and other

duties which, by law, can only be controlled by the Public Service Department. A smaller Code with a larger building department would result in better public service, quicker results and less violations.

When Mr. Hammond, in his remarks, states that in his opinion, and also that of many architects both in and out of the American Institute, the code has a tendency to discourage many building enterprises, he is correct. The truth of his remarks can be easily verified by questioning architects and engineers whose clients have given up the idea of building hotels and office buildings, etc., as an investment, when they found they were limited as to the amount of land they could cover, this limit being further increased by the necessity of light courts, and when satisfied to comply with these conditions for the sake of fire protection, access, air, light and ventilation, they were further discouraged by (in many cases) an unreasonable limit of height. These conditions are all very important to the growth of a city where land of dimensions suitable for a large building in the downtown section costs a fortune.

The reasons stated explain to you why Cleveland for so many years lacked a good modern downtown hotel, and the splendid Statler hotel we now see about completed, would not be a realization if the Building Code had been literally enforced.

My paper only discussed the faults of the Building Code in a superficial way, but enough has been given to show the necessity for a more simple set of building regulations.

When I was Building Inspector I presented the following problem to my staff:

Given a corner lot in the downtown section, an owner wants to build the following building under one roof, and he wants the construction as economical as the law will allow.

Facing on one street he wants the entrance to a theater, with a balcony, seating about 2,000; on this same frontage he wishes stores, with offices above.

On the side street he wishes a cafe and bowling alley, a moving picture theater, and a dance hall and apartments upstairs.

Problem: How much lot can be occupied by this building? Where are the fire walls located? The boilers for heating purposes? The toilets for the theaters, etc., etc.?

Four of us worked this out over Sunday, and when we compared notes it was the exception to find we agreed. One employe who had had some six years' experience with the Building Code maintained for days that he was correct on a point where the majority had differed with him, but finally, and to my amusement, he one day came into my office and stated he hoped I had done nothing about that theater building, since he had suddenly discovered a section in the Code that, when applied, would in a measure make him wrong and the others correct. (Still he was not sure.)

Architect Elliot, who has worked on the State Building Code, pronounced the Cleveland Code "a scissors Code", and when asked to explain, he said: "A scissors Code is one made up with the use of a pair of scissors and a number of building

regulations from all parts of the country." More work may have been done on our Code with scissors in clipping than with the pen. A loose-leaf scrap book and a pot of paste made an excellent cradle to nurse to life the so-called 'best Building Code in the world.'"

Our Dreamland Dancing Pavilion was designed by a Minneapolis architect. He wrote for a copy of our Building Code, and weeks later, when two gentlemen brought a roll of blue prints that would choke a bulldog, I was astounded at the many corrections that would have to be made before the permit could be granted.

One word led to another, and finally I said: "If I remember correctly, didn't this department send you a Building Code to follow? Are you not the architects?" "No," one of them answered, "I am the firm's engineer and this gentleman is the draftsman. As a matter of fact our boss did try to study your Code, but finally he threw it into the waste paper basket and said, 'Here, boys, my time's too valuable to fool with this d... thing. I can better afford to send you to Cleveland for a week and pay your hotel and railroad fare. Let the Cleveland Building Inspector tell you what to do.'"

Mr. Allen's statement that the Building Code did not retard building operations because his building department, for the eight months of this year, had issued about 8 per cent more building permits than for the corresponding period of 1911, is no argument one way or the other. I have an equal right to say that if it were not for the unreasonable restrictions of our Building Code the increase he states as being about 8 per cent would have been nearer 40 per cent if we had a more reasonable Code.

Mr. Emerson stated that it is no easy matter to write a set of building regulations. I agree with him, because it is so hard the less we say the better. Let us stick to safe, sane and sanitary regulations which can be enforced alike to everyone; then have these regulations added to or amended every year, keeping pace with the times, with an up-to-date Code, rather than, as is now the case, having a Code, only 30 per cent of which is being enforced. After six years of operation of the Code I lay claim to the fact that I was the first to draw attention to the ambiguities of these regulations and the impossibility of enforcing, at best, more than half of them. I started a rapid campaign of amendments, which I notice Mr. Allen intends to keep up. It should be every Building Inspector's duty to keep his Code up to date, by repealing and amending sections from time to time.

I was criticized by a friend for finding fault with the laws I was trying to enforce, and when I showed him certain sections as an excuse for my attitude he said, "Marani, leave the Code alone. It is the best political club you ever had, only you don't know how to use it, and anyhow its conflictions are good for you in this way; if you make a mistake and it is brought against you, you are sure to find some section of the Code that will let you out." (Laughter.)

Mr. Blaser does not approve of the division used in the Code of class and grade, but in this I don't agree with him.

Class, as called for in the Code, relates purely to the kind of construction, while *grade* is a housing condition, or the use to which one intends to put the building. As one relates to construction and the other to occupancy, I think this method of division good, though the divisions of grade should be amended as there is no sense (as at present) in having a church and police station in the first grade, and a lodging house and factory building in the second grade, and subject to conditions for first and second grade buildings.

Mr. Blaser in his remarks on Sec. 411 is one of the many intelligent engineers who doesn't understand the Code. No one here has ever volunteered to explain Sec. 411. Secs. 819 and 820 are just as ambiguous, and so are a great many more, but the time and space of my paper cannot cover all objections to the Code, or some of the legal interpretations put upon certain sections.

Sec. 952 states that all garages shall be deemed stables and regulated as such, etc. I refused a permit because an owner wished to build a garage closer to his dwelling than is allowed for a stable. His lawyer, on the other hand, made me own that an automobile did not do all the things a horse does. It was not a horse and it did not eat hay or do other things (laughter), therefore I had no right to regulate the garage from a sanitary standpoint, and if from a fire risk point of view, I could not stop the erection of this garage if the owner made it absolutely fire-proof, etc., etc. (And he was right.)

Mr. Henderer, Mr. Hammond and other gentlemen are correct; we need less Code and a more efficient building department.

The Rose, Williamson, Guardian Trust, Schofield and other excellent buildings were erected before our Code was written; they could not be replaced if our present Building Code were enforced. And if the Code had been enforced literally, permits would not have been granted for the Locomotive Engineers, Statler Hotel, Athletic Club, Y. M. C. A., Court House, Post Office and other buildings, all of which contain violations in one or more features.

As Mr. Hammond and Mr. Vorce stated, there is much in the Bible no longer acceptable to the orthodox Christian, so also there is much material in the Code no longer acceptable to the orthodox engineer, architect or builder. The Bible has been changed and most of it dropped out entirely. We are becoming a better people with a smaller Bible, so also we can continue to improve our cities in building operations with less Code, but of better material.

I appreciate what a Building Inspector has to contend with when a Building Code like ours hangs over his head, with a building department and appropriation only large enough to enforce 30 per cent of it.

This Code is a good deal like some legal documents; you know how they read: "To wit—and wherefore—party of the first part agrees as aforesaid with party of the second part—the beforementioned—" and so on. When you get to the end of

such a document (or before that even) you wonder who you are and where you come in. You think you are being cheated out of something. So also with our Code. I have started to look up a certain matter, but before I got through all the ambiguities and cross references, I forgot what it was I started out to look up.

I do not think anything more need be said, excepting that I hope that any action taken by the engineers or architects will be a step forward and not backward, and that we will have a smaller Code, all of which could be enforced alike to all.

BUILDING CODES

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Brick Street Paving

BY WILL P. BLAIR.

I am not sure that the members of this Society know of the commercial relationship that this city bears to the subject I am going to talk to you about this evening. I am not sure that you are acquainted with its relationship to the state itself. Cuyahoga county has an investment of about one million dollars for the production of paving brick, and in the production of clay products and paving brick the state of Ohio has invested more capital and produces more value in money than any other state in the Union.

I am not sure that you know of the reputation that the city of Cleveland bears for vitrified brick pavements. As a matter of fact, Cleveland has more mileage of brick pavement than any other city in the Union. She has the greatest mileage of what we designate brick pavements of good construction, and I say that particularly because some of the things that I shall say to you will be said in the nature of criticism in a friendly way of the Cleveland pavements. While they are generally recognized as good, there is yet room for considerable improvement. Because they are so good, Cleveland has a record of which the city and its citizens ought to be proud.

The number of men who have had charge of the streets and roads in the city of Cleveland is less than that of any other large city in the Union.

The subject ought to be of great interest to engineers because of two facts: One is that there is a larger budget for the expenditure of money on roads and pavements this coming year than for any other purpose within the United States, something more than a million dollars a day for the construction of streets and roads; and the other is that at least one-half of that money will be wasted.

And now I want to take up the subject in detail with reference to the essentials that are involved in the most approved methods of constructing brick pavements.

One of the most important things is the preparation of the foundation upon which the pavement is to be built, and that involves a subject that has been neglected to a considerable extent in this county and in this city—the subject of drainage. Drainage is important in the construction of all kinds of pavements containing an artificial wearing surface. I doubt not that it will be made very apparent this spring. When the frost shall pass away and pavements begin to settle, you will find an unusual expansion to have taken place during this extraordinary winter and many of our pavements to have cracked, owing to the expansion by freezing of the moisture under the pavements—the moisture that should have been taken away by artificial drainage. This is true

of the city streets and it is also true of the wonderful system of brick county roads in Cuyahoga county. I am not going into detail as to how this drainage should be taken care of, except to say that the moisture must be taken off quickly. The prevalent custom of passing a drain down the center of the highway, carrying the water along underneath the roadway is bad, especially when it is done with open-joined tiles. The earth becomes filled with moisture and during the winter, expansion by freezing occurs and the pavements are raised and cracked.

The foundation must be made smooth and compact, corresponding with the grade of the finished street. In this a great deal of carelessness is displayed, and a great deal of bad judgment on the part of contractors and those in charge of the work. I remember very well when inspecting a prepared foundation in the city of Columbus, last summer, that the engineer and the contractor agreed that it was necessary to pass a very heavy roller over the foundation in order to compact it. They actually had a roller weighing nearly twenty tons on that roadway, but the condition of the soil was such that it was utterly impossible to compress it. The soil was of a spongy character and it was impossible to compact it with such a heavy roller. I was very much gratified to have pass along by the side of us an intelligent workman who, hearing the discussion regarding the heavy roller, said: "Gentlemen, you can't do any good with a roller like that, you can't do as much good as you could with a little roller."

He stuck a stick into the foundation and after passing through the first 3 inches with some difficulty, he shoved it down easily 3 or 4 feet. We found that in using the roller the earth continually bulged up before it and was not affected below a depth of 3 inches.

The great mistake in this country is the use of rollers that are way beyond the necessary weight. A few years ago I had occasion to have a well point driven in the ground, and being unable to employ a man who understood the work, I employed one who did not. He labored for a day or two with a very heavy maul to put down that point, but did not succeed. Finally a man came along with a small maul and in less than four hours drove the point down. The lighter tool and lighter stroke proved effective. It is the same in compacting the foundation of a pavement. The repeated application of a light roller is more effective than the use of one much heavier.

The next step is the preparation for, and the installation of the concrete foundation. The concrete foundation must be of uniform depth and of a uniformly smooth surface. Generally, where concrete is used, the pavements are left with a very uneven surface. Many engineers and many contractors contend that it is next to impossible to smooth off the pavement with any degree of economy.

Another and very important reason why the foundation should be smooth is that with brick pavements there must be a uniform 2-inch cushion placed upon the concrete foundation. It is impossible to make that cushion uniformly 2 inches in depth unless you have a uniformly smooth foundation to put it on.

A smooth foundation is required by the best experts in the country in the construction of both asphalt and brick pavements. A few years ago it was contended that you should always have the surface of the foundation rough if you would have the asphalt adhere to it. I recall a conversation with Mr. Richardson, in which he said: "We have the same trouble inducing the engineers and contractors throughout the country to secure a uniformly smooth surface in the construction of asphalt pavements that you have in the construction of brick pavements."

The rumbling noise often complained of is generally ascribed by writers to the surface itself having raised off the foundation; but nine times out of ten the noise occurs because the depth of the sand cushion is not uniform. It has not been compressed and is not of uniform thickness, and vibration has settled it so that there is a separation between the sand cushion and the brick. You have possibly noticed this rumbling noise. It is the noise resulting from the settlement of the sand from the wearing surface and not from the raising of the surface. The sand settled because it was not uniformly compressed in the first place.

I recollect reading, a short time ago, an article by Mr. Flag, an architect. He stated that the pavements in Liverpool, England, had been placed upon a sand cushion of $\frac{1}{2}$ inch. That, we claim, will afford an insufficient relief, and a shattering of the cement filler will result. The cement that unites the bricks in a monolithic form will be destroyed.

One of the best methods for compressing this sand cushion is rolling. I suppose that 50 per cent of the pavements in Cleveland have been built upon a sand cushion that has been merely dressed off without any compression at all. During the last few years the attention of the engineering department has been called to this subject and it is now receiving proper attention.

The next step is that of placing the brick upon this sand cushion. Just here is a little thing that is as important almost as any step in the construction of brick pavements. It is that the brick shall be placed with the best edge up, and the lugs should lie in one direction. With brick pavements that idea is as important as in the construction of buildings, but it seems to have been lost sight of altogether. Lugs are now generally employed, although one of the leading engineers of the country, whom I regard very highly, Mr. Whinery of New York, being called to Chicago a short time ago as a consulting engineer and advising that city with reference to pavements, said: "There should not be lugs in brick pavements because it gives too much trouble in laying."

Such advice is in my judgment a serious mistake. Care and skill are greatly lacking in nearly all municipal work and should be encouraged. Lugs are important in lessening the hazard of failure in the pavement itself, and, of course, they must be made to lie in one direction.

The next step after the laying of the brick, is the rolling, and that should be with a steam roller. Many of the pavements in this city have been rolled with a horse roller and often with one altogether too heavy. Bad results follow in every instance.

It careens the bricks as it goes in one direction and it careens them in the opposite direction as it goes back. As it turns them in one direction, the sand rolls under and the uniformly even cushion that you have prepared, upon which to place the brick, has been made uneven by the process of rolling, and the longer you roll with a horse roller the rougher you get the pavement. The only instrument with which it is possible to do this properly is a little steam roller weighing about four or five tons. This sends the brick down perpendicularly into the sand cushion.

Now, with that process ended the next thing is the application of the cement filling. The advocacy of some people for soft fillers for brick pavement carries with it the supposition that something is wrong; at least, that the man who advocates it has not looked carefully into the proposition.

See that the cement filler shall be made in the proportion of one to one, and that it be applied in such manner as to insure its being in place in this proportion. Specifications that are written covering this part of the work are too often indefinite and so the best manner and method are too seldom employed, and often the process used practically assures a failure. The filler must be in the proportion of one to one. I am not going very deeply into the effects of the contraction and expansion of unevenly prepared mixtures of cement mortars, but it is necessary to see that the proportion is maintained so that the contraction and expansion will be even and the mortar have its full strength. The best way that I know anything about, the best method that I have seen in the application of a cement filler, is to mix it in a box standing on uneven legs so that the cement mixture will flow back into the lower corner of the box, as it is being stirred, and so that every portion of the cement mixture strikes every other portion in the box and keeps it in perfect agitation. Lift it out quickly with a scoop-shovel, pull the scoop out of the mixture and let it fall on the pavement flowing and sweep into the open joint and the proportion is easily secured. With this method it is possible to put into pavement the proper filler. But the problem of expansion and contraction must be taken care of even though the mixture be in the right proportion, because the pavement under heat will expand. That should not be done, as I have seen it done during the past season in the city of Cleveland, where in some instances the open space for the expansion cushion was arranged for by the use of a weatherboard wedged up so that in the application of the cement filler it ran under the board and occupied at least half of the space between the ends of the brick and curb. When the asphalt filler was poured in, there was no expansion relief whatever. An unobserving person would suppose the street was provided with an expansion cushion. One would naturally dispute the effectiveness of the provision in case a rupture should occur.

I found, too, in a number of places, some ordinary boards not 3 feet long, used in providing for the expansion cushion.

Out of twenty-seven eruptions that took place at the intersections of streets in Cleveland last year, I examined twelve, in company with Mr. Abbott, the engineer, in charge, and we found

an entire absence or lack of provision against expansion, and in the remaining number of disturbed intersections he told me that he found the same conditions. The expansion cushion, to answer the purpose effectively, must be uniform to the depth of the brick as well as uniform in width.

Last year, the United States Bureau of Standards had three men in Cleveland about four months, setting plugs in the pavements for use in measuring their contraction and expansion. The record of measurements between these plugs will some day add materially to our knowledge of the behavior of pavements.

The usual way to care for pavement expansion is to place an asphalt filler about 1 or $1\frac{1}{2}$ inches in thickness along the curb on each side of the street. This filler should extend below the bottom of the brick. Transverse expansion joints are unnecessary. I am unable to say why, but in practice where transverse expansion joints have been used it is found that the pavement travels backward and forward and the effect is injurious to the pavement.

Feb. 27, 1912.

A Visit to Sir Henry Bessemer

BY S. T. WELLMAN.

About twenty years ago, while crossing the Atlantic, I happened to be on the same ship with Mr. Andrew Carnegie. Shortly before landing he asked me if I would not like to meet Sir Henry Bessemer. I answered that nothing would please me better. "Well," he said, "within a few days after we reach London, I will try to arrange for it," which he did by making an appointment with Sir Henry to come out to his residence at Denmark Hill, in the suburbs of London; so one morning we drove out there, and spent several hours with him.

Sir Henry Bessemer was a tall, fine looking man, a typical Englishman and a good talker, who liked nothing better than to talk about the early history of the steel business. He first took us around the grounds, which were very large, containing 30 to 40 acres. I cannot better describe the place than by copying the following from a London paper. The house stands on high ground, looking toward the Crystal Palace.

"From the terrace of Sir Henry Bessemer's house the distant view is singularly pleasing and essentially English in its unhidden sylvan character. The foreground of the picture is almost entirely manufactured. Its natural slope toward the valley is perhaps generally maintained, but hills have grown where there were depressions, rocks have sprouted forth where there was nothing but gravel, and a lake with its feeder and outlet forms part of the purely artificial river system. Beyond the superbly terraced lawns is a sweet bit of real nature, a meadow, in which the tall rye grass, buttercups, and ox-eyed daisies wave at every puff of wind, making the rich carpet red, yellow and white by turns. At the lower side of this flat meadow is a bowling green, level as a billiard table, and separated from it by a rim of ground ivy, next to which comes a triumph of landscape gardening—a great clump of rhododendrons on the rocky shore of the picturesque lake—'Nowhere,' Sir Henry Bessemer tells his guests, 'more than 18 inches deep, an excellent depth for summer boating and winter skating, and most convenient if a child falls out of the boat or the ice gives way.' Around the lake are thick shrubberies, in which hawthorn, jasmine, and honeysuckle contend with the lilac, laburnum, laurel and innumerable rhododendrons. Presently the host vanished in a bush as if by pantomimic trick, and in a moment reappears and leads the way into a cavern filled with a magnificent collection of ferns, heated to the precise temperature, and lighted by a skillful combination of toplights and mirrors. At one extremity of this cave, lined with rocks made of brick and cement, is a waterfall pouring over a glass wall; at the other a snug little smoking room, looking over the lake, with all necessary

refreshments hidden behind a rock, apparently as massive as a cheese ring, and of nearly the same outline."

The walls of these rooms, as well as the hill itself, were built of a great variety of stone. Sir Henry told us with a great deal of glee of the visit, not long before, of a celebrated geologist, who, when shown the caves and rooms, was delighted to see such a collection of rocks and was able to tell his host exactly what part of the world many of them came from, but was very much nonplused and could hardly believe him when Sir Henry told him that they were all artificial.

After wandering around the beautiful grounds as long as we wished, we were invited into the library, and were entertained for two or three hours by Mr. Bessemer with his history of his early experience in the manufacture of steel.

He explained that the reason he was first induced to think of an experiment with a new process of iron making was the knowledge which came to him that the French Emperor, Louis Napoleon, was seeking a material to make better artillery than was then in use. Bessemer's first idea was that he could make an improved wrought iron by blowing air through the liquid iron instead of stirring it with a rabble to bring it in contact with metallic oxides, as was the practice in the puddling furnace. To carry out this idea, he constructed a small stationary converter of fire brick. This was about 3 feet inside diameter and considerable more in height. The pipes or tuyeres entered at the side not much above the bottom. They were all connected with the blast box which encircled the converter—a pipe leading from this to the blowing engine.

The converter was covered and a hole in the side near the top was left as an outlet for the flame. When it was finished, he sent to the iron store for "a ton of pig iron"—no other specification. Any old thing would do, so long as it was pig iron. Here was Bessemer's lucky day. He knew nothing at that time about the chemistry of iron or what composition was necessary in the iron to make good steel. So it was pure chance that it so happened that the iron sent to fill his order was the only brand, "Blaenavon", made in all Great Britain at that time that would have made good malleable steel under the conditions by which it was made. It was low in phosphorus and sulphur, high in silicon and contained a little manganese. So the first trial was successful in making a metal which, when tried in a neighboring iron works, rolled and hammered successfully. The bars were treated in many ways, both hot and cold, and proved to be so strong and tough that it created a great deal of interest in all who saw it.

Mr. Bessemer said that if the steel had been made from any other brand of iron made in Great Britain, that the result would surely have been such a worthless metal, brittle and rotten at all temperatures, that he would have abandoned the experiment at once. Surely it was a lucky chance that sent him to that iron dealer.

Bessemer immediately took out patents on the process and as the British Society met soon after at Cheltenham (this was in 1856), he prepared a paper on the new process, which was read,

and exhibited his samples. The paper created a great deal of excitement among the iron makers present, so much so that before the meeting closed he sold shop rights to the five leading iron works of England for the sum of ten thousand pounds each, and went back to his home with the cash. As I have said before, very little was known of the chemistry of iron and absolutely nothing of steel.

As soon as possible all of the licensees of the new process built converters at their own works and tried to make steel from their own iron, but every one of the experiments was a dismal failure, and not a pound of malleable steel could be made. It was, of course, a great surprise to every one, including Mr. Bessemer. He was branded as a trickster and thief, and every effort was made to get the money back, but he was not the kind of man to do that. He knew that there must be a reason why one kind of pig iron would make good steel and another brand would not, and he determined to find out the reason, but it would take time and money to do it. Luckily he now had both; so he went to work. He found a chemist who thought he could work out a method for finding the composition of the various samples. He succeeded in demonstrating that the good steel was low in phosphorus and sulphur, while the bad was very high in both these elements.

Mr. Bessemer kept all this knowledge to himself, and went quietly to work to build a small converting plant with which to experiment and to demonstrate the process. Meanwhile, he went to work with the help of some friends to buy back the shop rights which he had sold, as he had formed very much higher ideas as to the value of his process than at first. This he succeeded in doing, paying for one right 10,000 pounds and for another 20,000 pounds, or twice as much as he had received. When his experimental plant was ready, he made a journey to the West Cumberland district to arrange for some iron. The ores from which the first iron he had used was made had come from there, and he had discovered that it and the West Cumberland ores were low in phosphorus, so he ordered some iron made from that ore. It was duly received at the works and the first steel in the new plant was made, but very much to his surprise it was no better than that made by his licensees. Then he had the iron analyzed and found it high in phosphorus. He could not understand how this could happen when the ore was so free from this bad element; so he journeyed back to the West Cumberland furnace, to find the trouble, if possible.

In walking around the plant with the manager, he came across a large pile of black looking rock or other mineral, and asked what it was. The manager told him that it was the flux he used. Well, what was it? Why, it was puddle furnace cinder; this, he knew, must contain a large percentage of phosphorus; he had found the cause of the trouble sure enough. "Why do you use it?" he asked. "Why, to make the furnace work smooth and the iron fluid." The result of the visit was an order for more iron to be made from straight ore with no puddle cinder. The

order was filled and was billed as "Bessemer iron"—a trade name, which it bears to this day.

The next experiment was successful and the steel turned out was all right in every respect and fully as good as the first trial—the samples from which were shown at Cheltenham. It was now comparatively smooth sailing for the new works and he was soon able to demonstrate that he could make uniformly good steel that was strong and tough, hot or cold; also, steel of any carbonization desired, hard or soft. His old friends, from whom he had bought back the licenses, then came and demanded them back, but he said no, the process was much more valuable than he at first supposed and he had decided not to sell any shop rights, but would license any one to use the process for a royalty of one pound sterling per ton for rails, two pounds for all other work. This royalty he insisted on, and it was paid by all users of the process in England during the life of the patent.

The process very soon came into general use, as the trade was ripe for it. It was just what was wanted, particularly for rails. The old wrought iron rails were very poor and the "Bessemer steel rail" filled a long felt want; without it the great railroads of the world would be almost impossible. The first rail was laid at the Crewe Station of the London & Northwestern railroad and wore out 23 iron rails.

Bessemer soon found that manganese was necessary in the iron to make the steel malleable when hot in rolling or hammering, but the process of adding a carbide of manganese to this mixture was the idea of another inventor, Robert Mushet, who thus became a rival of Bessemer, and as Mushet sold an interest in the patent to one of the iron companies who were trying to get back the shop right which they had sold back to Bessemer, they used this as a lever to demand a very large royalty from Bessemer for the use of the manganese patent. Through this a great deal of bad feeling was worked up between Bessemer and Mushet. The handling and caring for Mushet's patent was left by him to one of his partners, and he, by some oversight or negligence, allowed the patent to lapse by a failure to pay the annual fees when due; so, very much to Bessemer's surprise and joy, he learned one morning that this had happened, and that Mushet's patent was public property; that he as well as all others were free to use it. Bessemer's process was useless without Mushet's invention, and Mushet ought to have made a fortune out of it, but he made nothing, and died a poor man.

Several years after the lapsing of Mushet's patent, one evening there was a knock at Mr. Bessemer's door. On opening it the servant found a young woman, poorly dressed, who asked to see Mr. Bessemer. She was shown into the library and introduced herself to Mr. Bessemer as the daughter of Mr. Mushet. She said she had heard that he was a kind-hearted man; she had come of her own free will to tell him that her father and his family were very poor and suffering for the necessities of life; she knew that by the aid of her father's invention he was being helped to make a great deal of money, and she thought that perhaps he would help them in their great need. The result of this

appeal was that Mr. Bessemer during the remainder of Mr. Mushet's life paid him a pension of 300 pounds per year, thus proving the truth of what the daughter had heard. It certainly was a noble act.

Bessemer's model works soon became the mecca of the iron men of England, for here were worked out all the early problems of Bessemer steel making. The stationary converter was soon abandoned for the tipping converter, mounted on trunnions, with a removable bottom, in which were placed the fire clay tuyeres. Except in some minor details, this beautifully simple piece of apparatus has remained unchanged for 50 years. The works in Sheffield still is in operation under the name of Henry Bessemer & Co. He made a large fortune from the royalties acquired in England, but comparatively little from the rest of the world.

For many years, more steel was produced by the Bessemer process than all others put together, but now the basic open-hearth has passed it in tonnage, and it would seem that the day was not far distant, when, as A. L. Holley used to predict, the "open-hearth" would go to the funeral of the "Bessemer process". The reason for this is not hard to see. The "acid Bessemer process" must have pig iron low in phosphorus and sulphur, high in silicon, within very close limits; the "basic Bessemer" must have high phosphorus, low sulphur and silicon. The particular kind of ores necessary to make these kinds of iron are getting more scarce every year.

While for the basic open-hearth only low silicon is essential, phosphorus and sulphur can be removed by the process and much lower phosphorus and sulphur be left in the finished steel than is found in the average Bessemer.

In several works in this country, a process is in use in which high silicon pig iron, also high in phosphorus, is used; most of the silicon and carbon are blown out in the Bessemer converter, the metal being then removed to an open-hearth furnace, where the phosphorus and sulphur and the remainder of the carbon are removed and the steel finished.

Bessemer was a very versatile inventor, but the bulk of his fortune was made from his steel process. The patent for this expired in 1870. During its life he received in royalties over 1,000,000 pounds sterling. Very seldom has an inventor been so well rewarded for an invention.

One invention of his was "Bessemer gold powder", the method of manufacture of which he did not patent, but kept a secret. Only four or five workmen were employed, as the machinery was automatic. After he had made his fortune from steel, he gave the gold powder business outright to the two leading workmen who had grown old in his employ.

He was the inventor of several patents on sugar mill machinery, also for a system of furnaces using combustion under very high pressure. He spent a great deal of money on this but nothing came of it.

He only left England on one occasion, when he crossed the Channel to France. He was so terribly sick that he came near dying, but this set him to working on an idea for a steady cabin

steamer. Thousands of pounds were spent in building a very large boat embodying his idea, but was a failure and was broken up. If this had been a success he said he would have visited America, but much as he desired to come, he did not dare to take the risk.

He was always busy at something new. At the time of our visit he was working on a solar furnace, using a large number of 24-inch lenses. The rays of the sun coming through, were concentrated in a small furnace, resulting in a tremendous temperature. I never heard the result of this experiment.

I bid good-bye to our host with regret and shall never forget the visit. I never saw him but once again, just for a few moments, in London.

Society Notes

MINUTES OF MEETINGS

May 14, 1912.—Regular meeting of the Society called to order by President Roberts at 7:45 P. M. Present about eighty members and guests. Minutes of April 9 and 23 read and approved.

Tellers reported the election of the entire membership ballot. (See names in Minutes of April 9, 1912.)

Applications for membership were received and passed for letter ballot as follows:

For active members—WHITFIELD R. CARSON, ROBERT P. HUTCHINSON, BENJAMIN D. FULLER and FRED H. VOSE.

The Nominating Committee's report was received and accepted, placing in nomination the following list of members for the elective offices to be filled at the regular meeting in June:

R. H. FERNALD, M. E., A. M., PH. D., *President*.

A. J. HIMES, C. E., *Vice President*.

F. W. BALLARD, M. S., *Director for two years*.

E. H. WHITLOCK, M. E., *Director for two years*.

Copy of Revised Constitution, signed by Messrs. G. F. Burrows, A. J. Himes, B. A. Stowe and E. S. Carman, was read, and upon motion duly seconded the Secretary was instructed to prepare same for letter ballot to be canvassed at the regular meeting in June.

President Roberts announced that the members of The Cleveland Engineering Society were invited to attend the business sessions of the convention of the American Society of Mechanical Engineers in the Chamber of Commerce Auditorium, on Wednesday, Thursday and Friday mornings, May 29, 30 and 31, and members and their immediate lady friends are invited to the boat ride on Thursday, May 30.

The program for the evening consisted of two papers on "River and Harbor Improvement". Col. John Millis, U. S. A., discussed this subject from an engineering standpoint, and Chas. W. Hopkinson, architect, from an esthetic standpoint.

A short discussion followed by Messrs. Abbott, Millis, Himes and Hopkinson.

A vote of thanks was tendered the speakers of the evening.

Adjourned to May 27, 1912.

B. A. STOWE, *Acting Secretary*.

May 16, 1912.—Special meeting called to order by President Roberts at 8:15 P. M.

Present about 150 members and guests (ladies included).

President Roberts introduced the speaker, Mr. Ambrose Swasey, who gave an illustrated talk on "China".

At the close of Mr. Swasey's talk a vote of thanks was tendered for his interesting talk, and light refreshments were served by the Hart Catering Co.

Meeting adjourned.

G. S. BLACK, *Acting Secretary*.

May 27, 1912.—Adjourned meeting called to order by President Roberts at 7:45 p. m. Present about 100 members and guests.

The purpose of this meeting being to receive applications for membership, the following list of names was presented upon call of the President and passed for letter ballot:

For active members—HERBERT J. BEVER, ERNEST J. LEES, HERBERT R. PALMER, FRANK F. SEAMAN, HOWARD L. WADSWORTH and JAMES H. WHITE.

For associate members—HARRY R. ATWATER, RALPH E. HYDE, EDWIN B. HATFIELD, RALPH McNALLY and HOMER J. WEEKS.

The President introduced the Speaker, Mr. Willard Beahan, who gave an interesting talk on "The Engineering of Men".

A vote of thanks was tendered Mr. Beahan for his excellent address. Adjourned.

G. S. BLACK, *Acting Secretary*

June 11, 1912.—Thirty-second annual meeting and banquet was held at the Hotel Euclid, commencing at 7 p. m. Present 90 members and guests.

Motion was carried to dispense with the reading of the Minutes.

The Secretary reported that the membership ballot had been unanimously approved (list of names in Minutes of May 14 and 27); also, that the revised constitution had received unanimous approval by ballot.

The result of ballot for election of officers was as follows:

For President—

R. H. FERNALD.....	85
A. J. HIMES.....	1
B. R. LEFFLER.....	1

For Vice President—

A. J. HIMES.....	84
B. R. LEFFLER.....	1
G. F. BURROWS.....	1

For Directors—

F. W. BALLARD.....	87
E. H. WHITLOCK.....	87

After the dinner the program consisted of short addresses, the speakers being introduced by F. C. Osborn, who acted as Toastmaster.

"The Incubator Stage in the Development of Engineers"—Jas. F. Barker. "The Brooder Stage in the Development of Engineers"—Dr. Chas. F. Mabery. "The Private Employer of Engineers"—Albert W. Johnston. "The Expert Testimony of Engineers"—Henry J. Davies. "The Value of an Engineer as a Member of a Society for Improving Civic Conditions"—Homer H. Johnson. "The Municipal Employer of Engineers"—Hon. Newton D. Baker.

Col. John Millis, who was to speak on "The Government Employer of Engineers", was called out of town, and Secretary Ballard read a short review of the past two years' work of the Society.

"Address by the Retiring President"—E. P. Roberts. "Address by the President Elect"—Dr. R. H. Fernald.

Meeting adjourned with singing "America".

F. W. BALLARD, *Secretary*

Over one hundred members and guests of the Society enjoyed the outing and inspection trip through the plants of the American Steel & Wire Co., on Tuesday afternoon, Oct. 1. Delightful weather and an exceptional opportunity for gaining knowledge combined to make the trip unusually pleasant.

Mr. William M. Faber and a number of capable assistants directed the party and explained equipment and operation. Our comfort and convenience was served by our hosts providing a special train on the Newburg & South Shore, to take us from the Central Furnace to the Cuyahoga Plant, and later to the Newburg Mills, where late in the afternoon the party disbanded.

INFORMAL MEETINGS AND FELLOWSHIP.

The first of a series of informal meetings was held in the rooms of the Society on the evening of Sept. 19. President Himes gave a short talk on "Repairs to a Masonry Dam". At the second informal gathering, held on Oct. 15, Dr. A. W. Smith, of Case School, discussed "Boiler Waters and Methods of Softening".

The purpose of these meetings is to create a clearing house for the exchange of engineering knowledge and experience and to afford an opportunity for the members to come into close acquaintance. If the social feeling experienced at these two meetings is correctly judged, it appears that a comparatively small amount of initiative will develop a "get-together" spirit of great beneficial effect to the Society.

A noticeable feature of both meetings was the general participation without constraint in the discussion of the subject of the evening.

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The publication of papers in the JOURNAL is not intended as
an endorsement of their contents by the Society.

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The Public Control of Non-Navigable Streams from a Sanitary Standpoint

BY PROFESSOR H. N. OGDEN,
Cornell University, Ithaca, N. Y.

On April 9, 1907, Mr. R. Winthrop Pratt, at that time Engineer for the State Board of Health of Ohio, presented a paper before this club on "The State Protection of Purity of Inland Waters". After explaining the probable origin of the laws protecting the individual rights of riparian owners, Mr. Pratt pointed out the increasing difficulty of assuring the protection of the quality of streams by this common law method. He showed that, while the common law afforded means by which one riparian owner could secure redress against injury from another who had interfered either with the natural flow of the stream or with its normal conditions of purity, yet the increasing density of population and particularly the rapid growth of cities and towns, continually demanded more thorough means for protecting inland waters. He suggested that the conditions clearly point to the necessity, not only for specific statutory provisions against stream pollution, but also for supervision and control by some state or national authority whose duty should be to investigate all matters relating to stream pollution, and to see that sewage and other polluting substances are not allowed to enter in their raw and unpurified condition any stream or lake where either a water supply would be endangered or offensive conditions would result. He cited the English Public Health Acts and the English Rivers Pollution Acts as well as the constitutions of the various State Boards of Health in this country, and seemed to imply that the remedy for the present unsatisfactory condition of stream regulation would be found by *enlarging the powers of the State Boards of Health* and at the same time giving to them sufficient authority to enforce such regulations as they may see fit to enact.

There can be no doubt of the growing importance of the subject. The recent movements in the interests of conservation have emphasized the desirability of including the maintenance of the purity of inland waters as a most important phase of that movement. Those who have been interested in the formation of a National Board of Health have in every instance cited the need of *national oversight of inland streams* as one of the important functions of that body, if constituted, and, according to their program, such a National Board might relieve the State Boards of their duties or responsibilities as to the pollution of streams.

It is my purpose, tonight, to consider these two suggested centralized bodies and their ability to deal with the question of the control of inland waters and to come to some conclusion, if

possible, as to the relative merits of these two bodies, or of any other body which may seem to be better fitted than these two for the purposes in mind. And I am led to this inquiry because of the evident demand on all sides for some adequate control that shall bring order out of the present chaotic methods of dealing with stream regulation, and because the methods of meeting such demands have been so varied. The problem is the same in all parts of the country and consists in essence of assuring to the public at large the maintenance of their rights in streams, whether it be for irrigation, power or other use, and of curbing the individual avarice which forgets the public rights in its own greed.

Without, at this point, giving further explanation, I may say that in my opinion, neither Mr. Pratt, suggesting enlarged duties for the State Boards of Health, nor the proposed National Board of Health, assuming direct charge of the purity of streams, has found the best solution and that later on I shall offer to you a method of control which seems to me more reasonable and more likely than either to bring about a just distribution of the material values resident in even the smallest streams.

In the first place, let us briefly review the present needs and difficulties which seem to indicate that the common law method of protecting the rights of riparian owners and at the same time safeguarding the interests of the public is inadequate, and needs re-inforcement from some centralized authority. The various points which should be considered in this connection may be grouped under five heads, namely; first, the rights of riparian owners to water for the purpose of irrigation; second, the rights of riparian owners in the regulation of streams, through the construction of reservoirs, for power purposes; third, the need of riparian owners for help against flood flows which have resulted in large part from changed conditions of the watersheds outside of their control; fourth, the needs of adjacent municipalities for the water of the streams for the purpose of municipal water supply; and, fifth, the rights of municipalities to use natural waterways for the purpose of drainage.

WATER USED
FOR IRRIGATION

In all states where the common law has not been recently amended, the owners of lands abutting on bodies of water are accorded by that law certain specific rights, differing from those belonging to the public generally, and known as riparian rights. Such owners may use for domestic purposes the water in the streams on which their lands border. The courts have established their right to demand that the natural flow of the stream be unimpeded, and that the quality of the water be maintained in its original degree of purity, modified only by such interference as may be inevitable through the reasonable domestic use by other owners farther up-stream. Such owners are entitled to the right of access, that is, the right to erect wharves to reach the navigable portion of the stream. They may use the shore immediately adjacent, as, for instance, for ferry purposes or for drawing nets. They may anchor boats in front of their property even if such anchorage interferes somewhat with public navigation. Many other judicial decisions might be cited to show the protec-

tion which the courts have given to these favored property owners.

Yet, apparently, of late years, there is a tendency to encroach upon these individual rights for the benefit of the public as a whole; and the growing inclination on the part of courts to restrict the operations of corporations, if it appears that the welfare of the public is affected, and to protect the people from extortion by the legal establishment of reasonable profits, marks the growth of the same paternalistic spirit.

Riparian rights in a stream have always been in conflict with the needs of water for irrigation purposes and apparently the Roman doctrine of "appropriation for beneficial use" has been recognized in the western states as of more import than the Common Law rulings on riparian rights. As Mr. Lewis, State Engineer of Oregon, puts it: "By the former doctrine, water is treated as a wild thing which becomes the property of him who captures it first. It can only be retained by him so long as he puts it to beneficial use. If, among a series of water-takers, the supply is not sufficient for all, the ditch of the last appropriator is closed to protect the prior appropriators." In a review of irrigation laws in *Mills Irrigation Manual*, it is pointed out that it seems to have been an accepted fact that water in streams was the property of the public and that, when the necessities of the people required, it should be conducted from the stream and applied to the soil for the production of crops and that the right of the public to such use was unquestionable. But, by the common law doctrine, no water for irrigation could be used if its withdrawal interfered with the full enjoyment of riparian rights down-stream.

In the development of the recent irrigation law in the State of Oregon, the high ground is taken that a comprehensive plan for the development of the state's water resources is essential if waste is to be avoided and the public good promoted. The law takes the position that public necessity demands that water be put to the highest use and ignores completely the riparian owners, whose rights as individuals had hitherto been so tenaciously guarded. In case of conflict between power development and irrigation the Board of Control has authority to forbid the use of the water for power purposes when public necessity demands its withdrawal for agricultural purposes. The law, in contradistinction to that of riparian rights, even grants titles and records rights to definite volumes of water in streams without regard for the common law theory which would give to riparian owners down-stream the right to the full measure of the flow unrestricted in quantity. This modification or entire change of attitude is very suggestive because it points the way to other modifications of riparian rights provided the public good can be shown to be better served by some other way of using the streams.

Even, however, under the new Oregon law, a difficulty arises from the fact that the streams used for irrigation are not always entirely within the boundary of a single state. Already in the West, difficulties have arisen and suits have been brought by citizens of one state demanding that the volume of flow in an inter-state stream be not reduced in the up-stream state, because the waters to their full volume were wanted by the citizens of

another state. As an example, the case of *Kansas vs. Colorado* may be cited, in which the decision of the United States Supreme Court abolishes riparian rights in water, at least so far as interstate streams are concerned.

The citizens of Kansas insisted that large quantities of water were being diverted from the Arkansas river by the inhabitants of Colorado, a large number of whom claimed to be prior appropriators and were diverting the water to non-riparian lands, as against Kansas, a lower riparian proprietor. In Kansas, the modified doctrine of riparian rights prevailed, while in Colorado prior appropriation was, and is, recognized as the governing doctrine. The Court refused injunctive relief to Kansas, and dismissed the bill, stating in substance that if the riparian doctrine should prevail in Kansas as against Colorado and against the non-riparian users whose rights were involved therein, Oklahoma and its citizens lower on the Arkansas river might invoke the same rule in opposition to citizens of both Kansas and Colorado, to their great injury, which doctrine, it is observed, would be ruinous in its effects. The Court, in dismissing the bill, indicated that no injunction would lie until a more substantial injury could be shown, although at the same time, the Court found that the interference by a large number of appropriators above in the State of Colorado materially depleted the flow to the riparian lands of the plaintiff.

Mr. Lewis comments on this decision by saying that there can be no misunderstanding of the clear intent of the Supreme Court to permit of the diversion of water in an upper state by non-riparian proprietors, even though such diversions materially deplete the flow to riparian lands in the lower state. "From the definition of a riparian right, as heretofore given," he says, "we observe that it is a property right inseparably annexed to the soil and passes with it, not as an easement, or appurtenance, but as a part and parcel of the land. It is, therefore, a vested right to private property, which, under the Constitution of the United States, the owner cannot be deprived of without due process of law, nor taken for public use without just compensation. We must assume that this recent, able and carefully considered opinion of the Supreme Court is not in violation of this section of the Constitution, and that it is applicable alike to all states. Therefore, we cannot escape from the conclusion that the common law doctrine of riparian rights, which has been assumed as the law by the Courts in many of the Western and doubtless all of the Eastern states, is not the law, and therefore never has been the law, notwithstanding many decisions of the State Courts to the contrary, at least as to interstate waters. If it is not the law as to interstate waters within the State, it is difficult to conceive of any theory on which the State Courts could maintain such doctrine for those streams which are wholly within the State and are not tributary to navigable waters."

When the question of water rights was first considered in the State of Nevada, the Court held that the patentee of the government succeeded to all of its rights and among these was the right to have the water of a stream, theretofore diverted, re-

turned to its natural channel. But this case was overruled in *Jones vs. Adams*. And in *Reno vs. Stevenson* (20 Nev., 269) it was unequivocally declared that the common law doctrine of riparian rights was unsuited to the conditions of that State. In the leading case of *Clough vs. Wing* (2 Ariz., 371) it is said that "the common law, so far as the same applies to the use of water, has never been, and it is not now, suited to conditions that exist here."

If this same line of reasoning can be applied to all States of the Union, so that the atmosphere can be cleared for the enactment of a comprehensive system of titles to water for the United States as a whole, and if, therefore, riparian rights are not considered as vested rights by the Supreme Court, then the inevitable conclusion must be that water is the property of the public, and that Congress, under the domestic tranquillity and general welfare clauses, has power to adopt a comprehensive system of titles to water which will obviate the present turmoil and confusion as to water rights and will promote the general welfare of the nation by assigning to each stream that duty or function which it is best fitted to perform and making use of it for irrigation, for power, for drinking or drainage, as may seem to meet the best needs of the greatest number of people.

WATER USED FOR POWER PURPOSES The use of a stream for the development of power has generally been based on the common law and has involved ownership of the stream on which the power plant may be situated and of the lands which may be flooded by the back water of the dam. A long series of court decisions have established certain principles governing the reasonable use of such mill properties and indicate the legal rights of the different owners on the same stream. A number of such decisions deal with the detention of waters by dams and have established the fact that the owner of a mill property may not, for the purpose of operating his mill at certain times, withhold, through temporary storage, the ordinary run of water from the stream below. Many decisions upon the right of a power owner to flood other lands than his own have been rendered, based particularly on the effect of freshets in the stream. Nor must the operation of another mill up-stream nor the drainage of land in the vicinity be interfered with.

Many other principles might be given to show how general has been the practice of the Courts in limiting the development of power to those sites where the ownership of riparian lands made it possible. Of late years, however, the agitation in favor of conservation of natural resources has taken into account the question of water power and throughout the United States there is manifested a tendency to assume the ownership of water powers by the government, or by one State, and to exploit the same for the benefit of the people. In the West, the major portion of the undeveloped water powers are not located on private lands, but on the National Reserves, and although each State exercises control of public waters within its borders, it is impossible to use the water for power development without access to the stream and this must be given by the United States government, under whose

control the national forest reservations are placed. It has already been suggested by President Taft in his message of Feb. 2, 1912, that the United States government proceed on a generous scale, through co-operation with the several States, to develop such water powers and that the revenue derived from such development be made sufficient to cover the cost of administration.

In the article by Mr. Lewis, already referred to, the writer advocates the development of water power by the government, but strongly urges that the cost for such services should be that of maintenance plus interest on the development. Already the United States Reclamation Service in Idaho is developing power and selling it at low rates—so low that electricity is used for heating purposes in competition with coal. In New York State, the State authorities have considered the development of water powers in the Adirondack Reserve, but are restricted through earlier legislation which has prohibited, along with cutting timber, any flooding of State lands, so that the greater value of the water is lost by the desire to preserve the Adirondack wilderness inviolate.

In the argument for State or National control of water powers, it has been pointed out that effective competition between water powers is becoming more and more improbable. It has been shown that there has been a marked concentration of water power control in private hands and that this process is advancing rapidly. Indeed, the country was thoroughly aroused a few years ago by the newspaper prominence given to the fact that certain firms had acquired a succession of water powers and the editors took occasion to point out that just as the coal mines had fallen into the hands of corporations, which absolutely control the prices of this public necessity, so the consolidation of water powers in the hands of a few corporations would inevitably eliminate that competition of water powers with coal power, which now allows manufacturers to introduce some restriction on the unlimited demands of the coal barons.

In States where government lands do not exist, so that governmental development of water power is not feasible, it has been proposed in the interests of the public to tax existing water powers, either on the basis of the volume of water flowing over the dam, or of the actual horsepower developed, and the argument in favor of this sort of taxation is, that for the State to receive no compensation of any kind for the utilization of such great natural wealth producers as waterfalls, is to bring into existence the greatest possible factor of injustice in the matter of general taxation. Of all the States, New York has, perhaps, taken the most advanced stand in the matter of State control of its water powers, largely because of the vast extent of State lands on which these water powers are located. There are, however, beside those for State land sites, other plans for development on private lands.

In the bill known as the Fuller Bill, passed in 1907, it was enacted that the State Water Supply Commission should collect information relating to all the water powers of the State and should devise plans for the development of such water powers as it deemed available. It contemplates the construction of power plants by the State and the selling of such water power to indi-

viduals at such revenues as may be necessary, for defraying the cost of necessary lands and riparian rights, for meeting the annual cost of maintenance and depreciation, and for such sinking funds as may be necessary to pay off the whole cost of construction with the interest thereon. Under this act, many surveys have been made, designs for dams and water power plants made, but no actual construction has as yet been undertaken. Some storage reservoirs have been built in the Adirondacks and the cost of construction met by a State bond issue, to be paid by the power companies benefited through an annual rental per horsepower.

Pennsylvania also has a Water Supply Commission with extensive power in certain directions. The enabling act provides that no application for the charter of incorporation for the development of storage or for transportation of water for commercial and manufacturing purposes shall be approved until the same has received the sanction of the Commission.

The State of Wisconsin, with its usual broadminded attitude toward public questions, has considered the question of water power control and in a report to the Legislature in 1909 a bill was proposed embodying the following features:

“(1) Declaring the use of water for power purposes to be a public use and subject to the control of the State for the greatest public good;

(2) Repealing all water power franchises, subject to repeal, granted prior to the passage of the act, and providing for their re-issue under the new act;

(3) Providing for sale of surplus power developed;

(4) All holders of new franchises to pay to the State an annual fee based on the franchise value of the horsepower put to beneficial use at a rate of not less than 10 cents nor more than \$2 per annum;

(5) No franchise to hold longer than for a period of 40 years; rights then to revert to the State exclusive of physical property which may be removed or condemned;

(6) Providing for forfeiture of franchise if annual fees are not paid, failure to develop power, or failure to comply with terms of franchise;

(7) On the termination of the franchise, the State reserves the right to acquire the water powers by purchase, lease or condemnation proceedings, and further reserves the right to manage, regulate and control the use and distribution of the power and the rates at which the power is sold.”

(NOTE.—This bill has since been enacted and later been declared unconstitutional by the Courts.)

It will not be necessary to elaborate any further the tendency already pointed out in the matter of irrigation towards limiting the right of private companies to exploit water in streams for individual purposes. The same feeling that has led to the establishment of irrigation laws based on the greatest beneficial use of the water to the surrounding communities is rapidly growing to include the rights of the State in the use of water for power purposes before which the rights of the individual must give way. Ownership of the stream and ownership of the riparian rights is

not proof against the right of the State in eminent domain. It has long been understood that for public utilities, such as water-works or transportation, the Legislature could and did grant with the franchise the right for the incorporating company to seize private lands, leaving for the owner no redress except such monetary compensation as the Courts or their agents might award. The change in attitude really consists in recognizing water powers as public utilities, in which the public good requires the sacrifice of private rights. The principle is apparently established that the good of the people as a whole requires state control if not state ownership of water powers and so the common law doctrine of riparian rights disappears. The policy which has been established by the Supreme Court of the United States, namely, that any State or municipality has a right to fix charges in the case of a public utility company, selling its products within the limits of such State or municipality, then controls.

WATER
FOR STORAGE A third instance of the growing interference by State or governmental authority in private rights is to be found in the regulation of flood flows of torrential streams. With the urban and agricultural development of lands hitherto uncultivated, if not protected by forests, comes more rapid run-off and marked soil erosion. It is maintained by members of the Geological Survey that flood tendencies have increased in this country, due almost entirely to recent modifications in surface conditions. Obviously, the complexity of the problem and the impossibility of assigning to any one act the direct responsibility for any specific flood damage absolutely prevent action by any riparian owner at common law to secure the normal stream flow unaffected by flood flows. If injuries to property become unbearable, the only recourse is through private construction of dikes which will give the protection, forced upon the riparian owner by the behavior of his upstream neighbors.

The national government, through its interest in navigable streams, has long since assumed certain responsibilities for flood conditions in the larger rivers of this country. Many million dollars have been spent along the Mississippi and each year seems to show that the expenditures must continually increase so long as the present methods are adhered to. But on non-navigable streams the national government has no interest and great anxiety is being aroused to devise adequate means for public relief. The most popular plan is found in the construction of storage reservoirs that shall store up the flood volumes in large amounts and pay out the same at times of low water. This, of course, adds largely to the value of the water powers on the stream and should appeal to the mill owners sufficiently to bring about the construction as a private enterprise. But the small jealousies between manufacturers and the practical difficulties involved in securing concerted action by the several varied interests involved, make such a method of indirect control of freshets practically impossible. In New England, however, there has been a large installation of reservoirs for water power purposes that has undoubtedly resulted in a substantial reduction in flood damages

in the lower reaches of the rivers on which such reservoirs are located. Mr. Leighton, of the U. S. Geological Survey, estimates that probably 10 per cent of the flood waters that originate in New York and New England are saved by storage in artificial reservoirs, lakes and ponds. In Minnesota, at the head of the upper Mississippi river, practically the entire flood drainage from an extensive area is conserved. In the arid West, there has been an extensive installation of reservoirs, some of which store practically all the flood waters on their respective basins.

Although the New York State Commission, as constituted by the Fuller Bill, exists primarily for the better development of the water resources of the State, yet the Commission has not overlooked the fact that great artificial lakes, created primarily for power purposes, will operate to mitigate the severity of floods. On the Genesee river, extensive surveys have been made with a view to the construction of a large impounding reservoir near the celebrated Portage viaduct, where, with the primary intention of preventing a repetition of the extensive damages committed by floods in times past, a profitable source of power may also be provided. On the Canaseraga creek the powers of the Conservation Commission to improve existing conditions by the construction of impounding reservoirs have been thoroughly tested in the courts. The highest judicial authority of New York State has ruled that the action of the Commission was justifiable and that the contentions of the plaintiffs would not stand. Acting under the provisions of Chapter 734 of the Laws of 1904 and at the instance of certain persons possessing riparian rights in the creek who represented that the present regulation of the stream was insufficient, the Water Supply Commission proceeded a few years ago to make the necessary surveys and to enter into a contract for the work required for improvement and regulation. The claim was made by one riparian owner, whose land was seized for the purpose of the improvement, that such taking of property was unconstitutional in that just compensation was not given and on the further ground that the Commission was not entitled to acquire lands by the exercise of the power of eminent domain. The Court of Appeals ruled that the action of the Commission was within the Constitution, that the interests of the State were sufficient to justify the right of eminent domain, and that the method adopted for compensating the riparian owners for their properties was reasonable and sufficient.

It is interesting in this connection to find that in France and in Switzerland those interested in the development of water powers under the rights of their charter or license are thereby allowed to seize any lands needed for reservoir or storage purposes and that the compensation therefor is determined by the same power granting the concession. This last feature is of interest as tending to prevent extortionate demands on the part of owners who see in the proposed construction an opportunity of bleeding the manufacturers. It is also of interest to remember that in France the Bureau of Hydraulics is a most important arm of the governmental service. This organization polices, patrols and guards all the waters of the country, whether publicly or

privately owned. In the mountainous parts of France most extensive and important enterprises have been carried out in certain regions exposed to the ravages of torrents. In Germany, on the other hand, the regulation and correction of streams is in the hands of the provincial governments. Each of the provinces has a "stream-building" commission with a chief engineer at its head, which controls design, construction and operation for each river flowing through several districts, so as to obtain uniform results for the entire river, and much work in the way of regulation of freshets and in the protection of banks has been done under their direction.

WATER FOR DOMESTIC USE In the matter of water supplies for domestic purposes the tendency, already noted in the case of irrigation, to make the State supreme and, in case of water power companies, to overrule the individual ownership for the sake of the public at large, has not been so manifest. The old theory of riparian rights has generally prevailed and the inducements by which investors have been persuaded to undertake the task of waterworks construction have come, either from the hope of profit in the case of the private company, or from the actual needs of the community, in the case of municipal ownership. Since waterworks for supplying cities and towns with water are for municipal purposes, the Legislature may confer authority to condemn private property, may, subject to Federal approval for interstate streams, authorize the erection of a dam in a navigable river and may allow water in quantity to be taken from public streams or ponds.

Full compensation must be granted to all riparian owners whose rights are in any way interfered with and, except in the cases where the supply is taken from large rivers or lakes, the indemnity demanded for the withdrawal of water becomes a large factor in the cost of construction. Thus, the City of Syracuse, which in 1894 built a supply main from Skaneateles Lake to the city, was forced to construct a dam for storage purposes and therefore to interfere with the normal flow in the lake outlet. Under condemnation proceedings, the city was obliged to pay to the thirty-six mill owners along the outlet the sum of \$462,000 as compensation for the water power withheld. The State of New York also, wherever the natural flow of any stream has been interfered with for canal purposes, has been forced by the riparian ownership theory to make heavy returns for the water taken away.

The right of the State to overrule private ownership for public purposes is unquestioned, but generous compensation is always exacted. Thus, in the case of the Barge Canal in New York State, now under construction, a large dam has been built on the Mohawk river above Rome at the little village of Delta, wiping out the village and obliging residents, much against their wills in many cases, to accept the stipulated compensation and find a new home. The amounts of money that the city of New York has paid or is to pay for interference with riparian rights, because of the construction of the Catskill aqueduct and the diversion of the waters of the Esopus creek, are so great as to

leave no question of the justice of the compensation. The point of interest is that the city has full legal powers to so interfere with apparent vested rights on many miles of river.

Until recently, there has been no attempt to go beyond the needs of the single city in its search for water and to consider as a substitute the greater economy to be obtained by the union of several communities. A large city on the lake shore may reasonably extend its water intake pipe several miles into the lake in its search for pure water. A small village, on the other hand, may be equally in need of the same water and altogether helpless, financially, in the matter of obtaining it. A most interesting problem is now being worked out in New York State, where the Conservation Commission is undertaking the modest task of providing a public water supply for some sixty villages. In that region, there is none available at reasonable cost, so the State has undertaken to develop in storage reservoirs a sufficient supply and to distribute it through about 200 miles of pipe.

There have been a few examples of water supply districts, such as the Boston Metropolitan District, where a commission has been duly authorized to proceed to develop a water supply for a city and its suburbs, but for a state to consider the needs of a community, unasked, is quite unique. This method, however, of supplying a community with water through the agency of the State is in direct contrast to the community method which has been practiced in some localities and which has also been utilized as a method of securing irrigation. In fact, Mr. Leighton reports that the acreage of land irrigated by community installations is altogether greater than that irrigated by private companies or by the government under the Reclamation Act.

WATER FOR
SEWAGE DILUTION

In the matter of sewage disposal, the riparian rights theory has almost unanimously been accepted, the one exception being through Legislative permission granted in Massachusetts, by which certain streams are dedicated to the use of the public and to perpetual pollution by manufacturing wastes. Until the State Boards of Health have within the last few years become active, all attempts to purify sewage have been made at the instigation of, and through pressure brought by, riparian owners. A suit at common law to obtain damages, on account of a polluted stream passing the property of a riparian owner, or an injunction obtained from a court to prohibit pollution shown to be objectionable, has resulted in numerous cases in the construction of sewage treatment plants, which, in many cases, have been absurdly disproportionate in cost to the amount of damage inflicted. Thus, the City of Columbus has been obliged to spend over \$1,000,000 to purify the sewage of the city because of a suit at common law by some farmers down-stream, whose continued damage could not have been more than a few thousand dollars at most.

The concentration of population in this country is growing so rapidly and the value of the manufacturing interests and the needs of the urban centers are so great that the matter of usefulness of streams can no longer be considered as formerly when

only farm lands and their interests were involved in any controversy between riparian owners. Perhaps no better example of the relative importance of the values involved can be cited than to refer to some of the streams of the Adirondack region of New York State, where pulp mills discharge sulphite liquor into the streams. This liquor is a weak sulphurous acid containing in solution a relatively small amount of lignin, dissolved from the spruce pulp. By reason of the great quantity of this waste discharged, the lignin becomes a nuisance in the streams, clinging to the rocks, forming a carpet on the bed of the stream, and, if exposed to the hot sun, decomposing and smelling bad. Some years ago, Justice Hughes, then Governor of New York State, was appealed to, under that provision of the Health Law of the State which requires the Governor to investigate complaints and to take such action as may seem to him necessary to restore the sanitary conditions violated. Through the investigations made by his direction, it seemed plain that a nuisance existed and that it was undoubtedly due to the discharge of the pulp mill wastes. However, no action was taken by the Governor, presumably because no efficient method of treating such sulphite wastes was known and because an order to purify such wastes before discharge into the streams would have resulted, in effect, in an order to close the mills, for the benefit of the small property owner who was the original complainant. No other action than that taken could have been found reasonable in view of the large interests involved and while the rights of the riparian owner were undoubtedly interfered with, the continuance of the nuisance was undoubtedly of greater benefit to the public as a whole.

Another instance may be given in the case of the sewers of Rochester, which heretofore have discharged into the Genesee river and have converted that stream into an elongated cesspool. Two years ago, to remove the nuisance from the vicinity, the people of Rochester devised, through their Engineer, Mr. Kuichling, the plan of carrying the sewage to Lake Ontario and discharging it into 50 feet of water, one and a half miles from shore. The plan aroused great opposition on the part of the so-called sanitarians of the city and of the State who foresaw the destruction of the rights of the public in boating and fishing hitherto enjoyed and the immediate conversion of the lake into a cesspool. It is probable that the addition of Rochester sewage to the lake will add somewhat to the contamination of the lake, but the most careful studies and the opinions of those best fitted to pass judgment on the matter, agree that the additional contamination will be infinitesimal and that, even if it were measurable, the greater interests of the city would furnish sufficient justification for such action.

SUPERVISION OF QUALITY OF WATER

There has, as yet, in this country been no centralized authority competent to pass judgment on the relative importance of the interests concerned in sewage pollution. In the case of irrigation and water power, we have seen that state authority has been invoked by which relative interests of the communities, the rights of riparian owners and the relative

importance of various propositions to use the water have been passed upon, so that the greater interests of the public have been conserved. In the matter of waterworks and sewage, however, this same authority has as yet not been constituted and we have only indications of the direction in which the tendency toward this same centralized authority will move. Boards of Health, indeed, in some states have authority to pronounce on the adequacy of proposed methods of sewage disposal and may insist upon a universal rule of purification to a fixed standard under all conditions of locality and stream flow. They may, indeed, privately consider the advisability of dedicating certain streams or lakes to the uses of a public water supply, and of giving up others to carry off waste matter, but no such public and reasonable dedication is in evidence. In New York State, as already pointed out, at Linden, we have an example of State assumption of centralized power invoked for the good of the community in the matter of water supply. On the other hand, we have examples, as with the Passaic valley sewage, where a number of villages and towns have, without any assistance on the part of the centralized authority, proceeded on their own account to dispose of sewage, the community plan being presumably cheaper than separate action.

There still remains, however, to consider the question of the propriety of the methods of disposal which may have been adopted, and this introduces a new element when compared with the problems heretofore considered. In irrigation questions, in water power questions, and in flood prevention questions, the legal rights involved are paramount and the engineering questions are left to the engineer in charge, who may solve them in the best possible way or not, according to his ability. In the case of waterworks, the element of quality enters and something more than the mere legal right to the water must be considered. Therefore, there is manifest the need for the disinterested advice or sanction of some higher authorized body. It is not enough for a central authority to find that public necessity for drinking water demands an over-ruling of private right. It must not allow a private company or municipality to furnish to its public impure or polluted water and surely this last function is as important as the first. No standard practice, however, has as yet been devised. In some states the State Board of Health has advisory powers. In New York State, the matter is brought before the Conservation Commission, although in rather a secondary way, the important points considered by it being legal rights, financial ability of the constructing company and non-interference with the rights of the public. In Massachusetts, the State Board of Health has perhaps greater power than in any other state and their status is so well established that it is not likely that any waterworks company selecting a source of supply would depart from the advice of the Board. The good quality is further maintained by the practice of State Boards of Health in making periodic examinations of the quality of water after construction and in reporting the same to the communities interested. The law of self-preservation operates, then, to force those responsible for bad waters to improve the

same. There is no authority, however, which can compel a water company forthwith to improve a supply.

The same thing is true of the disposal of sewage. Boards of Health have power to approve plans for sewage disposal plants and presumably consider the quality of the river water into which disposal is to be made as one of the factors in determining the degree of purification required. The recent English decision by which the City of Birmingham was upheld in its contention that so long as the effluent from their disposal plant was as good as the water of the river into which that effluent discharged, the law governing the purity of the stream was not broken and the purposes of the plant were being carried out, is of interest. If this were to hold generally, all that would be needed in the way of central authority would be a chemist to compare the qualities of sewage effluent with the waters of streams and a police force to insure modifications to produce equal qualities.

Having imperfectly reviewed present conditions of stream ownership, we may assert, as *the first item* in our conclusions, that there seems to be a well developed tendency for the State, acting through Commissioners or Boards of Control, to assume the duty of supervision and of direction as to the use to which non-navigable streams should be put. The tendency has advanced farthest in the West with streams used for irrigation, although the conservation movement has given a great impetus in the same direction in the East with streams used for water power.

As a second item, we may assert, equally confidently, that the old rigorous tenacity with which the rights of riparian owners were believed in and enforced, is weakening. And if the rapid growth of the country is considered, it is not difficult to see the reason why. Under rural conditions, the rights of the individuals are most jealously guarded. No law suits are more bitter than those between farmers who believe their sacred rights are invaded. Each family is almost independent and any extreme central authority is unnecessary, burdensome and rejected. As the same communities become more urban and the former conditions change, the need for a representative authority to adjudge the various interests becomes more and more acute as the interdependence increases. In much this way have the private legal rights, established at the expense of so much litigation, been outgrown and one might hopefully expect a recognition of these changed conditions except for the conservatism of the courts. They are always most unwilling to violate precedent and to give any new interpretations which are in defiance of old rulings.

As a third item, we may say that as sewerage is the last of the many municipal improvements undertaken by a city, so the need of extending the modern conception of public ownership in water to include the soiling of such waters is, or will be, the last to be released from the old riparian rights grip. Yet, such extension is inevitable and must not be overlooked when laws are being framed for more advanced and more comprehensive public rights in streams.

PLAN PROPOSED FOR
STREAM CONTROL

With some diffidence I venture to suggest that, among the many experiments already made, the most reasonable plan for the control of non-navigable streams has not yet been tried. State Commissions fail in the important particular that they have no jurisdiction beyond the State boundaries. Control by Boards of Health fails because they can have no interest except in the quality of the water and so are indifferent to, or even in conflict with, the use of the stream for power or for irrigation. Community voluntary agreement theoretically is a most promising method, but, due to the inertia of individuals and the difficulty of reconciling the various interests, most unlikely to be of general success.

In place of any of the above, the plan of control by river districts commends itself to me. Then each stream is considered by itself and its various needs and possibilities weighed one against the other. It would be considered as a unit from headwaters to the mouth. Such a control would have to be authorized by the Legislatures of the several States concerned and the Federal government. The initiatory motion would come from any group of persons or interests along the river. The actual authority would be lodged in a commission appointed by the Federal government, made up of representative men. The mill owners, the steamboat companies, the State Boards of Health, the agricultural interests and the conservation interests would all be represented. Such a commission might safely be entrusted to develop the highest usefulness of the water. They would have power to undertake improvements, to build storage reservoirs, to improve channels, to construct dikes, to locate dams, to pass judgment on the propriety of withdrawing water for domestic purposes and to decide on the degree of purification needed before sewage is admitted. Then there would be uniform and consistent regulation for the entire river and its tributaries. We should not see unpurified sewage discharged just above a waterworks intake, but we should see a progressive program intelligently adhered to after a comprehensive consideration of all the interests, with a view of giving to the public the best value the stream possesses.

It is not a new plan. In spite of the respect for centralized authority in Germany, such localized commissions are found to be the most efficient means of enforcing broad-minded policies. The recent organization of the Emscher-genossenschaft is a good example of a most successful solution of a perplexing sewage disposal problem by combining all the factors of the entire Emscher Valley. One of the eminent lawyers of Germany in a recent article in *Stahl und Eisen*, in commenting on the new Prussian law for the Control of Water in Streams, sums up his discussion by saying, "The fundamental thought which runs through the entire bill is that the public welfare is of supreme importance in the use of waterways."

In England, after years of unsuccessful struggle to preserve the purity of their streams either by the action of the centralized authority, the Local Government Board, or by the action of the County Councils, it has been found that the greatest success is

had by the establishment, under the direction of the central government, of Joint Committees or other bodies, representing all the counties through or by which a river or any tributary thereof passes and the conferring on such body all the powers of a sanitary authority. Largely through the efforts of the conservation enthusiasts, we of the United States have been partly awakened to the permanent needs of the people and there is seen a stirring up of a sense of trusteeship in the guardians of public interest. We recognize the interdependence of the several states. The fundamental principle of equity and law that each shall so use his own as not to injure others is felt to apply not only between man and man, but between State and State throughout the entire Union. And it is felt as never before that each State owes a sacred duty to each other commonwealth in connection with each resource. No longer, then, shall selfish and individualistic interests prevail. The public need replaces the personal rights. The exact evaluation of such needs in the case of rivers must come, it is maintained, by constituting local commissions which shall have full authority over the many conflicting public uses which may be made of that particular stream under their jurisdiction.

Discussion

MR. A. J. HIMES:—

About seventeen years ago, I read a paper before the Albany County Medical Society, on the water supply and sewerage of Albany, and there was constructed shortly afterwards at Albany the first large filtration plant in this country. In the discussion following the paper, a gentleman, who was then and is now at the head of one of the first engineering colleges of this country, gave expression to the idea that "God Almighty had created the streams to carry away the waste and refuse of mankind, and that it was silly and nonsensical to talk about preventing it." Immediately thereafter a great wave of public sentiment began to spread over the country adverse to the pollution of streams. This incident is referred to for the purpose of calling your attention to the necessity of keeping abreast of the current thought in engineering as well as other matters. Changes are taking place all around us, and it will not do for any one to think that what we learned in school was the last word. We must read the technical journals and the papers of the Engineering Societies, and learn what progress is being made from time to time.

In the case cited by Prof. Ogden, of the non-interference of Justice Hughes in the pollution of the streams of New York, we have another lesson. It seems quite clear that the reason Justice Hughes did not take means to stop the pollution was because he did not know how such pollution might be prevented in a practical manner. There were a number of engineers in the country at that time who could have told Justice Hughes how to

overcome the difficulty. It recalls to my mind one of the acts of our former mayor: During Tom Johnson's administration there was a time when only a particular rail section was permitted to be used by the street railway. The Council had prescribed this rail and seemed disposed to insist upon its use, but the railway officials said it was impractical, and that it could not be procured. That is a favorite position of big men who do not want to do that which they are called upon to do, and a weak and inefficient engineering department oftentimes accepts it as final; but Tom Johnson said: "I will get you the rails," and he did so. Now I suspect that if Justice Hughes, great man that he is, had had a little of the nature and training of Tom Johnson, or perhaps a little broader acquaintance among the engineers of the country, he might have found some way to stop that pollution. It is strictly within the province of our profession to point the way in the steps to a higher civilization, and that is primarily the work and the object of this Society. We are performing one of our duties on this occasion by giving our time and our attention to this subject, which now confronts the state of Ohio.

There is in New York state, or has been, a situation similar to that of Cleveland. Oswego is a comparatively small city, but it stands at the outlet of a very large drainage area, which extends over the central part of the state and which includes the drainage of Auburn and Syracuse. For many years the water supply of Oswego was taken from the river. There was started more than thirty years ago at Syracuse the famous Solvay Company, which proceeded to pollute the stream, and later a large pulp mill was built on the Oswego river and added its share to the pollution. Of course, the situation at Oswego is a little different because the population is so much smaller than that of Cleveland, but it may happen in the course of time that the water supply in the lake will become polluted also.

Professor Ogden has had some official connection with the Oswego case, and it would be interesting to hear his account of it.

PROF. H. N. OGDEN:—

It looks to me as if you were trying, Mr. President, to make me say something about the situation here. However, if I stick to Oswego, I can't say anything out of the way.

They did not have money enough in Oswego to go far enough out in the lake to get pure water. I did my best to persuade the people of Oswego that they would be much better off if they would put their sentiment in their pocket, and filter the river water; just as I told the court a week ago, that it would be perfectly safe to take the water supply from the Erie canal if it was filtered before use. They did not believe me, and they preferred to get the pure water of the lake; so they have gone out 2,000 feet. They are delighted with their lake water, but it remains to be seen what quality they get.

MR. C. F. SCHULZ:—

I will say that I am a believer in preventive measures rather than remedial measures, and I think what Cleveland is

doing here is the right thing so far as the situation here is concerned.

I would like to know how far the water intake of Oswego is from the sewage outlet of Rochester.

PROF. H. N. OGDEN :—

The river at Rochester discharges into the lake, about sixty miles west of Oswego. The water intake is one and one-half miles out in the lake and a little west of the mouth of the Oswego river. I imagine that wind coming from the east would cause pollution, although eminent engineers say there is no danger of pollution at that point. Certainly there is more danger from their own sewage than there is from the sewage of Rochester.

MR. C. F. SCHULZ :—

This year the death rate in Cleveland has been so low as to make us feel very sure our water supply is not polluted. Our intake is about eight miles from an intercepting sewer outlet, and four miles from the mouth of the river. I do not apprehend that we have any pollution from sewage here at present.

MR. A. J. HIMES :—

I might say that there is a very considerable current in the lake at Oswego. You will remember that the St. Lawrence is not far away, and the current coming out of the river starts immediately through the lake towards the east. They have very few east winds there. The intake is located a little west of the outlet of the river. The confidence of the people in their new water supply is based on long experience and knowledge of the currents in the lake and their peace of mind is assured until some bacteriologist comes along and shows that they really have objectionable bacteria in the water.

MR. R. W. PRATT :—

I do not know that I can say very much after Prof. Ogden's interesting and comprehensive paper.

I might point out, however, since Prof. Ogden has referred to the paper I read five years ago, that Ohio has made considerable progress as regards sanitary legislation, since that time.

In 1908, the legislature passed a law, which is known as the "Bense Act". This Act empowers the State Board of Health, after due investigation and after giving hearings to all persons interested, to order, with the approval of the Governor and Attorney-General, any municipality or private corporation, to purify its sewage, or purify its water supply, as the case may be.

An important and unique feature of this law, as compared with laws of other states, is the provision whereby such an order from the State Board of Health, when made to a municipality, authorizes and compels the legislative body of such municipality to issue such bonds as may be necessary to cover the cost of the desired improvement, the issuance of such bonds not to be counted in determining the legal limit of indebtedness incurred for other

purposes. The Executive Branch of the city government is also compelled, under such order, to complete the work.

This provision, besides being strong, has filled a need as regards Ohio cities, where the legal limit has been so low that it has been difficult to raise sufficient funds to supply the ordinary running needs of the municipality, to say nothing of building expensive sanitary works.

One of the most notable applications of this law has recently been made in the case of Cleveland.

Last summer, the State Board of Health examined the Cuyahoga river and found it to be polluted. They did not have to make an extended examination to discover that. (Laughter.) It ordered the city to remove the pollution from the river on or before July, 1915. The order was duly signed by the Governor and Attorney-General. The City Council has already issued bonds for \$2,000,000 for the purpose of complying with the order.

In the paper above referred to, read five years ago, the speaker stated that it was a difficult and expensive matter to purify sewage so that it would be an absolute protection to a water supply; but since that time, as is well known, there has been developed the use of chlorine as a disinfectant in connection with sewage purification, or rather as a means of purifying from a bacterial standpoint, sewage which has been but partially or roughly treated.

At the present time, therefore, there is available a more satisfactory and cheap method of protecting streams from pollution, viewed from a bacterial standpoint.

MR. ROBERT HOFFMANN:—

I was very much interested in Prof. Ogden's paper, and it would be presumption on my part to take exception to his conclusions, evidently made after much thought and study. What I have to say is not to be taken as an exception or criticism, but as a possible suggestion in the application of the methods proposed.

Prof. Ogden called our attention to the tendency of the times of giving greater thought and consideration to public rights and welfare as opposed to any conflicting private ones, such as riparian rights. It is a good indication of a progressive tendency when proposals are being made such as Prof. Ogden's.

The idea suggested is that some central or national control should be established which would exercise authority over rivers and drainage channels throughout the United States, stating definitely the uses to which such streams and channels could be put. It seems to me that the work now being undertaken by the State Boards of Health would be duplicated and that equally good results could be obtained by such Board of Control acting through the Boards of Health by establishing uniform regulations and underlying principals as a basis for the guidance of such Boards.

Well conducted Boards of Health obtain an intimate knowledge of local conditions and should be well prepared to pass judgment upon whether a stream should remain absolutely un-

contaminated or whether it would be permissible to use it as an outlet for sewage.

Boards of Health must be maintained for other reasons than control of water supply and direction of sewage purification, and it would appear more economical to enlarge their powers under suitable control than to introduce an additional board or commission established for such reasons alone.

DR. ROGER G. PERKINS:—

Not being a member of this Society, I am doubly grateful for the opportunity of hearing Professor Ogden's paper and the pleasure of discussing it. While the protection of non-navigable streams does not affect Cleveland directly, the various phases of water supply protection are so bound up together that each has a strong bearing on the other. We have our State Boards of Health, but they are unfortunately not equal in their efforts. In one state deep interest is taken in the problem, while in the neighboring states there is little or none, and co-operation is impossible. Accordingly, some more central authority, such as suggested in the paper, would appear best in this country. I had occasion to see a good deal of the work of the English Rivers Commissions a year or so ago. There in Yorkshire and in Lancashire there are Commissions which deal with the whole of a river without regard to the political boundaries. I saw one stream not larger than the Cuyahoga, where the entire flow was used many times by manufacturers and these had been forced so to treat their waste that salmon and other fish could be caught a short distance from the mouth of the stream in spite of its use for trade purposes.

In this country the great length of the rivers makes the consideration of each as a single problem difficult, but the fact that there has recently been established an Association for consideration of the entire problem of the Great Lakes Basin shows the appreciation of the needs and the possibilities. There is little doubt in my mind that the present method of taking care of sections of streams by one locality without co-operation with those adjacent will never be successful. But one point is clear, whether the control be federal or otherwise, sanitation demands that it should be efficient and continuous.

Prof. Ogden brought out another point, which is a sore one to the hygienist, that the water supply is apt to be the last phase considered, and that this as well as most of the improvements in public sanitation are considered on a financial rather than a public health basis.

PROF. H. N. OGDEN:—

It is very pleasant to know that in Ohio the State Board of Health is so well established. In New York, I am sure, some of our enterprising citizens would refuse to obey the mandates of the Board of Health. If I mistake not, in Pennsylvania some of the people have set themselves up as having a greater knowledge than the State Board of Health. In Pittsburgh there are citizens, who have set themselves up to say that the orders of the

Board cannot be carried out. Cleveland, I should say, is an easy mark for the State Board of Health. (Laughter and applause.)

I do not know a great deal about the topography of the state of Ohio, but if I mistake not, there is a considerable stream on its southern border; I do not know what authority your State Board of Health would have over that large stream, or what use it would be if Ohio purified it and the neighboring states along which it flowed did not do so.

In New York state we have streams coming into it from all sides, and some of them we use for drinking water, but we cannot get any of those states to purify them, and we are not going to purify our sewage for the benefit of our sister states if they fail to purify their sewage for us. So while the State Boards of Health do good work, they fail in many particulars. I should not like to have it said that the State Boards of Health are doing everything that might be done, because they are not. (Laughter.)

PUBLIC SANITARY CONTROL OF NON-NAVIGABLE STREAMS.

American Political Science Review, May, 1909—Stream pollution, by J. A. Lapp. Recent state legislation.

American Water Works Association Proceedings 1906, p. 61-78—River pollution, by M. O. Leighton. A discussion of its present status and suggestions concerning remedial policy. Discussion. Believes "that a concerted effort should be made to secure the passage of an act in Congress prohibiting the pollution of interstate waters, or, if such is believed to be unconstitutional, an effort should be made to secure the passage in each state of a joint act."

—1910, p. 80-91—Conservation of potable waters, by J. M. Diven; with discussion.

Association of Engineering Societies, Journal, Oct., 1907—State protection of the purity of inland waters, by R. W. Pratt. Discusses laws for securing pure water supplies and unpolluted streams in connection with the work of the State health departments.

Conference of Governors in the White House, Washington, D. C., May 13-15, 1908. Proceedings, p. 237-71.

Conservation of life and health by improved water supply, by G. M. Kober.

Discusses the influence of public water supply on the death rate. Appendix contains extracts from a review of the laws forbidding pollution of inland waters . . . statutory restrictions of water pollution.

Conference for Good City Government, Proceedings, 1910, p. 446-9.

City and state boards of health and the proposed federal department of health.

Suggests briefly in regard to the federal government "that for the present its health activities be . . . limited to those interstate fields in which the states are largely powerless, particularly to the sanitary protection of interstate water, milk, meat and other food supplies."

Engineering and Contracting, Nov. 8, 1911—The economic value of a public water supply resulting directly from improved sanitation alone, by W. H. Booker. Aims to show the difference in health and mortality among users of public and private supplies.

- Engineering News**, July 11, 1912—Water pollution control in Ohio. Gives the greater part of the opinion of the Court, compelling cities and villages to establish sewage purification plants.
- Engineering Record**, June 29, 1907—A judicial review of American stream pollution decisions. A review recently written by Judge Haines of the Oklahoma Supreme Court.
- Apr. 11, 1908—Water and sewage purification legislation in Ohio. A bill turning the control of stream pollution, sewage and water purification over to the State board of health. Also editorial, p. 479-80.
- June, 6, 1908—Conservation of life and health, by improved water supply. Abstract of address by G. M. Kober, presented at the Conference on Conservation of natural resources.
- Aug. 7, 1909—The pollution of streams. Gives the report submitted at the recent Washington Conference of State and Provincial Boards of Health. Recommends that the Federal government be given such control that it may be in a position to assist the states in studying special problems.
- Illinois Law Review**, Feb., 1911—Interstate nuisances; jurisdiction to abate; water rights in interstate streams; federal and state courts, by H. Schofield.
- Municipal Journal and Engineer**, Dec. 8, 1909—Results obtained by State health boards. S. G. Dixon tells what Pennsylvania is doing to purify the streams of the state, and H. M. Herbert tells what is being accomplished in New Jersey.
- Wisconsin Engineer**, June, 1907—Some relations of stream pollution and water purification, by C. C. Brown. Discusses the problems of stream pollution and the legal limitations; the legislation in various countries, and various parts of the United States, the damage to water supplies, the sources of water supply and the purification of water, etc.

American Ingot Iron Versus Steel

BY G. F. AHLBRANDT.

It is my purpose tonight to show the difference in the manufacture of American ingot iron against steel; to explain the real cause of corrosion and to show why American ingot iron is superior to steel from a rust-resisting standpoint.

Historical developments in the iron and steel industry would be interesting, but for lack of time we must pass directly to the modern method of iron and steel manufacture; namely, the open-hearth process. The open-hearth furnace is practically a puddling furnace of high power, as regards the temperature obtainable, and of great economy in the obtaining of that temperature. The manufacture of American ingot iron and steel by this process I will describe to you in detail by means of lantern slides.

When steel is made in an open-hearth furnace, the metal is tapped as soon as the charge is in the molten state, and when the carbon is worked out to the required point, while this molten metal is running into the ladle a recarburizer is added, consisting of carbon, manganese, phosphorus, etc., in order to make it more workable and to be of a definite chemical composition. The time required to manufacture 50 tons of steel is from seven to ten hours.

When American Ingot Iron is made in an open-hearth furnace, the purification stage just commences when the charge is in the molten state; the manufacture of this pure iron is a process of elimination from start to finish. Not only is the sulphur, phosphorus, carbon, manganese and silicon eliminated, but also the gases, such as oxygen, hydrogen and nitrogen, are reduced to a minimum. When the pure iron is tapped no recarburizer is added; in fact, nothing but a small quantity of degasifying agent, and this simply absorbs the last traces of oxygen and other gases that might be absorbed by the iron. The time required to manufacture 50 tons of this iron is from 10 to 15 hours.

The principal difference between the manufacture of steel and iron is, therefore, the omission of the very intense purification stage, the addition of a recarburizer and the increased output in a given time. Let us see what part this plays on the life of steel against pure iron.

CONSENSUS OF OPINION ON CAUSES OF CORROSION OF IRON AND STEEL.

Numerous investigators have studied the effect of manganese upon the corrosion of steel. Siemens (2*) believes that the presence of manganese in steel increases the readiness with which it corrodes. Snelus (3*) ascribes the pitting in steel to the irreg-

*See references, page 248.

ular distribution of manganese in the metal. Turner (4*) has observed that certain samples of manganese steel rust more readily than any other variety in the collection of specimens at the University of Birmingham, while it is well known that rich ferromanganese, when exposed to moist air, oxidizes with extreme rapidity. The late Dr. Dudley (5*) discovered, some years ago, that segregated manganese formed centers of corrosion, and it is a generally accepted fact that steels high in manganese are peculiarly liable to oxidation.

Cushman (6*) has carried on some careful investigations on the effect of manganese in steel, from which we note the following: "From the standpoint of the electrolytic theory, these are several reasons why the presence of manganese in steel should invite corrosion. Manganese decreases the electrical conductivity of iron, and as the percentage of manganese, starting from zero, rises, the electrical resistance increases up to a certain specific maximum. It will be seen that if the presence of manganese in iron raises the electrical resistance, any variation in the distribution of the manganese means that there will not be a constant electrical conductivity throughout its mass, or on any given surface. There is abundant evidence to show that manganese associates itself, to a considerable extent, with sulphur, when both these impurities are present in steel. (7*) That manganese sulphide shows a difference of electrical potential against iron is also well known."

These theoretical reasons, which indicate that manganese should stimulate corrosion of steel, provided it is not homogeneously distributed in the iron, appear to be justified by a number of reliable observers, among whom may be mentioned—Dudley (7*), Drown (7*), Abel (8*) and Reynolds (8*). Dr. Huntley (9*) deals with the corrosion of boiler steel, and gives details of a case of pitting in a boiler:—"Each pit was found to be the center of a blister, and the blister contained a slightly acid solution of ferrous sulphate, while the boiler water was alkaline with caustic soda. The solid matter in the envelope of the blister, which consisted of a mixture of iron oxides, acted as a semi-permeable membrane, keeping apart the ferrous sulphate within and the caustic soda outside the blister. The theory advanced is, that the particles of manganese sulphide segregated in the steel, were oxidized by the oxygen dissolved in the boiler water to sulphuric acid and an oxide of manganese, the acid then acting locally on the surface of the boiler plate in the vicinity of the particles of sulphide of manganese. Manganese also increases the occlusion of gases in steel. It is also known to fix oxygen on certain compounds, and that even the solid salts at suitable temperatures hasten the oxidation of many substances. The metal itself will precipitate iron from its solutions, and it is reasonable to infer that with iron going into solution in the presence of oxygen, if there is any manganese present, it will aid its precipitation as an oxide."

Stoughton (10*) on the corrosion of iron and steel has the following to say: "In short, manganese is only one, although

**See references, page 248.*

perhaps one of the worst of the evils we have to contend with. We should expect to find that the most resistant metal would be the one which was the most homogeneous in composition, and because the less the amount of impurity, the less the opportunity for an uneven distribution of it. We should expect that the purer the metal the more resistant it will prove to be. Both of these theories are borne out by the facts as we know them, and it has been found good practice to remove all impurities—not only manganese, but sulphur, phosphorus, silicon, carbon, and also gases which may occur with the metal, occluded in it, or separated in the form of blow-holes. It will, therefore, be readily understood that any irregularity in the composition of the metal which produces a difference in potential between two parts, no matter how close together, will increase the rate of corrosion, and this, no doubt, is one of the important reasons why metal charged with blow-holes or occluded gases, or in which the impurities are segregated, has rusted faster than better made material.

“American ingot iron, especially, if the manufacturers of it have succeeded in also avoiding blow-holes, oxides and slag, is a very advantageous feature, and should recommend it to users on theoretical grounds at least.”

D. W. MURPHY, GOVERNMENT ENGINEER,
In Charge of Reclamation Service, Article in *Engineering Record*.

“In connection with the work of the United States Reclamation Service on the Uncompahgre Project, Colorado, it is necessary, in order to reach a portion of the irrigable area, to carry about 42 cubic feet per second of water across a depression approximately 3,800 feet wide and having a maximum depth of about 200 feet. The soil along the line of the siphon contains a considerable amount of alkali, which has a strong corrosive action on ordinary iron and steel. For this reason it was decided if practicable to use for a siphon a material upon which the corrosive action of alkali would be a minimum. Re-inforced concrete, both on account of the action of alkali upon it, and the comparatively high head of the siphon, was not considered suitable. The results of recent investigations and tests on the corrosion of practically pure iron seemed to warrant this conclusion, that the lasting qualities of this material are superior to those of ordinary iron or steel, and that for this reason it was well adapted to the work. In arriving at this conclusion, weight was given to the well established fact that corrosion in iron is an electrolytic action, and that by removing the impurities from the iron such action would be greatly reduced. As far as known to the writer, this is the first example where heats of iron have been made to a limiting oxygen content specification.”

ELECTROLYTIC THEORY OF CORROSION.

The mass of evidence which has been presented proves that “corrosion is due to an electrolytic action and that the electrolytic theory is upon firm, solid ground.” This theory demands the elimination of those impurities which differ electro-chemically from the base metal. Further, the evidence proves conclusively

that the essence of the problem of rust-resistance depends most emphatically upon the purity of the iron, not only as it relates to sulphur, phosphorus, carbon, manganese and silicon, but also to copper, slag, oxygen, hydrogen and nitrogen contents. These are the impurities that set up positive and negative poles throughout the material, thus accelerating corrosion and causing pitting.

The *Electrolytic Theory* simplified is as follows: The action that takes place in the corrosion of iron or steel can be compared to the action that takes place in an ordinary telephone battery. In this battery the zinc is always eaten away and deposited on the copper, because there is a difference of what is known in the electrical world as *Potentiality*.

Now, applying this theory of iron and steel, the impurities in iron and steel and the pure metal act toward each other the same as zinc and copper act toward each other in the telephone battery. In damp weather a current is set up between the pure iron and the impurities because of their difference in potential, and the one is eaten away and deposited in the other. This action continues indefinitely until the material has been corroded. Hence, to overcome this action it is absolutely essential that the impurities be eliminated and that the sheet be homogeneous throughout.

We see from the above that all the impurities in iron or steel tend to accelerate corrosion more or less and hence it is absolutely necessary to use a pure iron if we are interested in durability. By removing the gases as well as the metalloids, we prevent pitting and tubercular corrosion. We find that the "purer the iron, the greater will it resist corrosion."

INFLUENCE OF COPPER ON IRON AND STEEL.

The addition of copper to ordinary steel has the property of retarding the solution of the steel in sulphuric acid. Copper is insoluble in dilute sulphuric acid and exerts a restraining influence upon the solubility in sulphuric acid of either iron or steel. It has been found that the addition of 0.25 of 1 per cent of copper will make steel resist the action of sulphuric acid to a high degree. Some manufacturers are advocating the use of copper steel when a rust-resisting product is desired. Such material is very high in impurities and must of necessity be badly segregated, and service tests prove that it will not resist natural corrosive influences.

Dr. A. S. Cushman says: "There is no evidence yet forthcoming to show that coppered steel is more resistant to general corrosion than ordinary steel. If segregation due to the presence of manganese, sulphur and carbon and stresses and strains due to carbon are responsible for localized corrosion known as 'pitting' or tuberculation, there is no reason why the addition of small amounts of copper should prove a cure for these difficulties. It is generally believed that purity is a desired quality in a metal when the highest resistance to localized segregated corrosion effects is the chief object sought."

Sir Robert Hadfield says: "I have made tests on the

specimens in question with regard to copper, with the following results :

Bill hook	0.012
Chisel	0.090
Nail	0.119

“I think in, a general way, these percentages might be termed coincidences; certainly, they are not intentional additions of copper.”

“As regards the effect of copper in adding resistance, all the specimens are more or less alike, whereas if this element had any influence, the nail ought to have shown less corrosion than the others. I think, therefore, you are right in not accepting the theory that the addition of copper will enable iron and steel to resist corrosion.” (The above abstract is taken from the *Journal of the Iron and Steel Institute*, Vol. 1, 1912, page 179.)

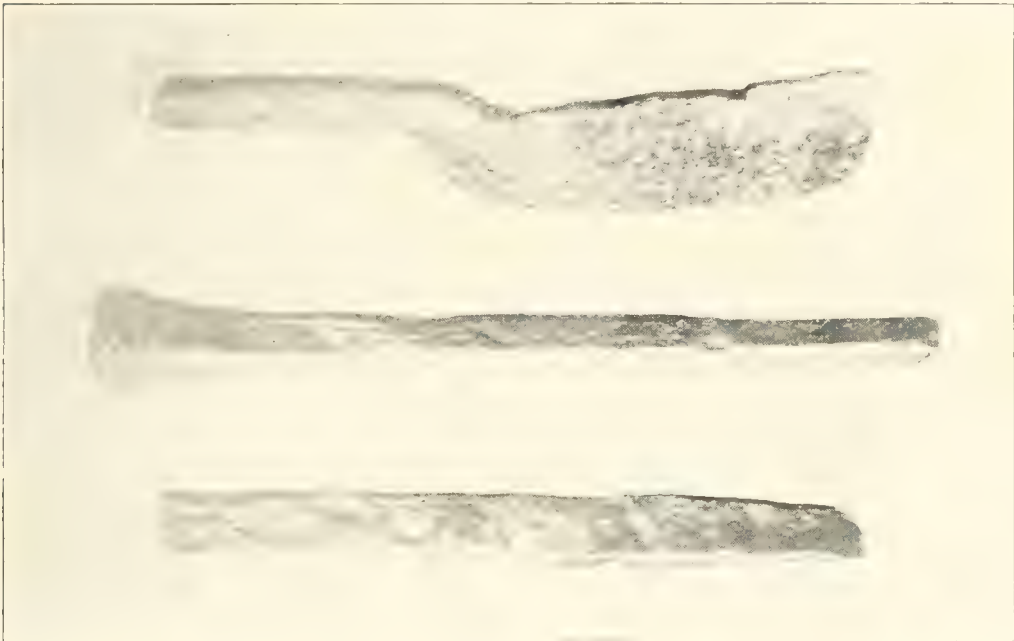


FIG. 1

The above shows that the addition of copper in either iron or steel will not increase its rust-resisting properties. Furthermore, the manufacture of iron or steel with a minimum copper content is a difficult and expensive proposition. We can easily add copper, but no method has been discovered up to the present time to eliminate this element. In order to manufacture an iron with a minimum copper content, it is absolutely necessary to use raw material which is low in copper. This would prevent the use of cheap borings and turnings, because all such turnings contain brass, babbitt metal, etc. Hence, in order to insure the greatest care in the manufacture of iron and steel and to secure the highest rust-resisting properties, we should insist on a low copper content.

I have endeavored to show the harmful effect of impurities from a corrosion standpoint. I have also shown the influence of

copper, manganese and gases and I will now aim to show that the presence of slag is not an indication of resistance to corrosion and also show the durability of American ingot iron over steel.

Fig. 1 represents specimens of iron dating from the fifth century, which are unusually resistant to corrosion. These samples were reported upon by Sir Robert Hadfield before the Iron and Steel Institute of Great Britain. These specimens represent a rude chisel, a nail and a bill hook, and are reported to have been exposed over 500 years. Chemical analysis shows the absence of carbon and manganese in every instance.



FIG. 2

ANALYSIS.

	Chisel.	Nail.	Bill Hook.
Sulphur	0.003		0.022
Phosphorus	0.28	0.32	0.34
Carbon	Trace	Trace	Trace
Manganese			Trace
Silicon	0.12	0.11	0.119
Copper	0.090	0.119	0.012
Sulphur			0.013
Phosphorus			0.25
Carbon			0.03
Manganese			0.06
Silicon			0.121
Copper			0.027

Fig. 2 shows a wrought nail in service 100 years and well preserved compared with steel nail in service only seven years and badly corroded. Wrought nail shows again low carbon and manganese, also low percentage of copper. This nail was used in the construction of the Masonic Hall at Richmond, Va., in 1807. In 1908, it was found half driven into the oak studding so that the head and half the shank were exposed to the century of service. It is in a remarkable state of preservation, the forged edges of the head remaining quite sharp and unrusted.



FIG. 3

Fig. 3 shows the band of a sleeve from a bronze cannon. Withstood the full force of the elements for many year. It is exceptionally pure iron.

Sulphur	0.005
Phosphorus	0.07
Carbon	0.01

Manganese	0.01
Silicon	
Copper	0.08

This old band or sleeve was attached to a bronze cannon captured from the British by the American troops at the storming of Stony Point in 1779. The cannon has been used for monumental purposes and has stood for many years exposed to the full force of the elements. The iron sleeve has been wonderfully rust-proof and the old hammer marks made when it was forged, are clear and sharp.

Fig. 4 shows three iron links from the famous old link suspension bridge, which was built in 1809 at Newburyport, Mass., and known as the Essex Merrimac Chain Bridge. This bridge was in continuous use until the late summer of 1909, having completed practically a full century of service. According to authentic records, this bridge has not been painted for 70 years,



FIG. 4

and the links, as you see, are in a remarkable state of preservation. Upon analysis these links proved to be almost chemically pure iron. Under the microscope they show the well-known ferrite structure almost free from slag. The oxygen content is but slightly higher than that of American ingot iron. The high purity, the comparative freedom from slag and the 100 years of service again proves that the purer the iron the better it will resist corrosion.

	Link A. Per Cent.	Link B. Per Cent.	Link C. Per Cent.
Carbon	0.05	0.12	0.04
Manganese	Trace	Trace	0.01
Sulphur	0.007	0.01	0.006
Phosphorus	0.032	0.07	0.02
Silicon	0.019	0.047	0.028
Copper	0.43	0.018	Trace

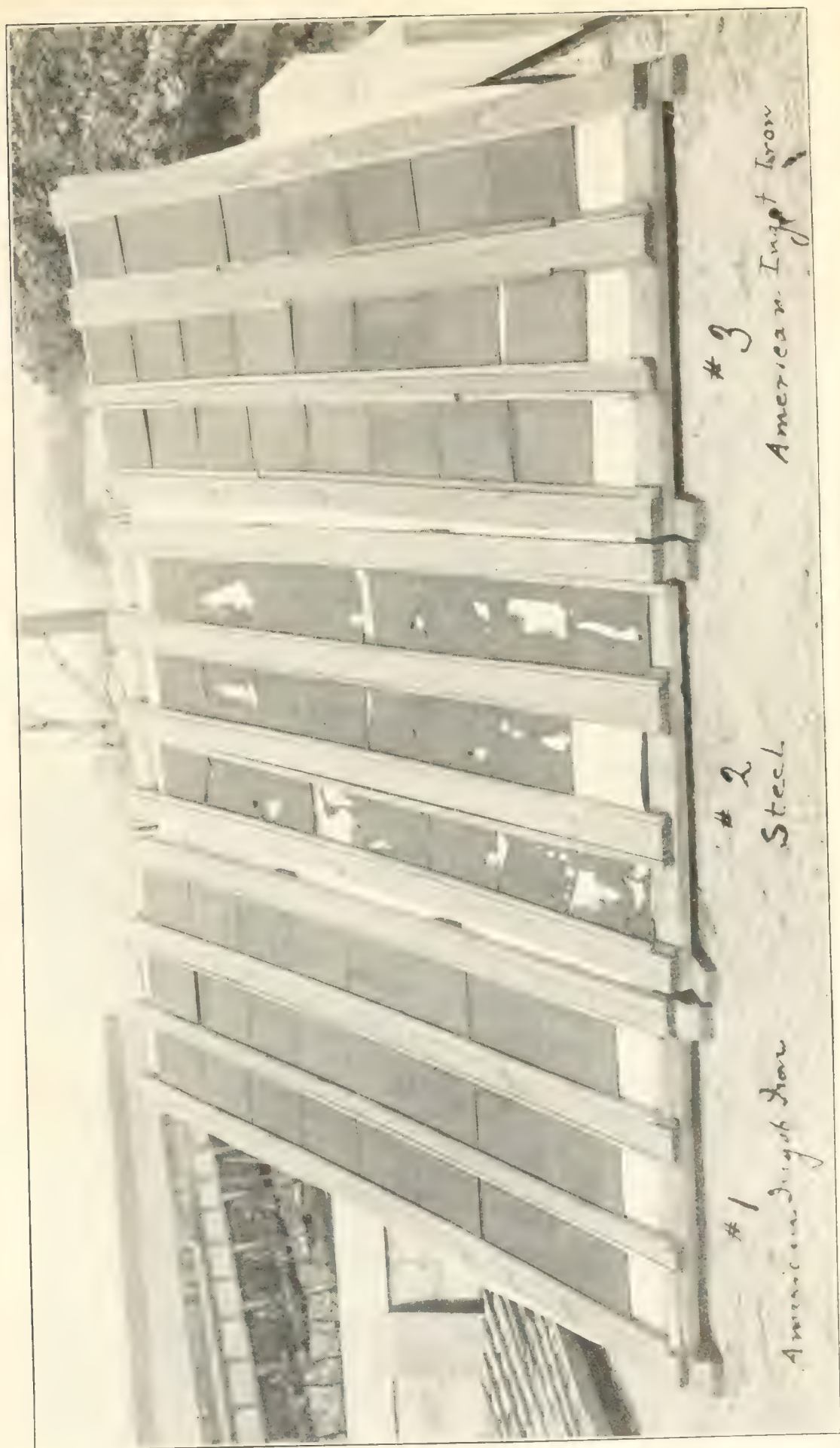


FIG. 5

Fig. 5 shows American Ingot Iron and steel exposed to the weather for 14 months. Notice the rapid corrosion of the steel. Figs. 6, 6-A, 6-B and 6-C show microscopic structures of



FIG. 6
A LONGITUDINAL SECTION PUDDLED IRON, SHOWING GRAINS OF FERRITE
AND BLACK SLAG LINES

ancient iron, steel and American ingot iron. Notice similarity of structure of American ingot iron to the structure of Newburyport link, also remarkable similarity in the analysis.

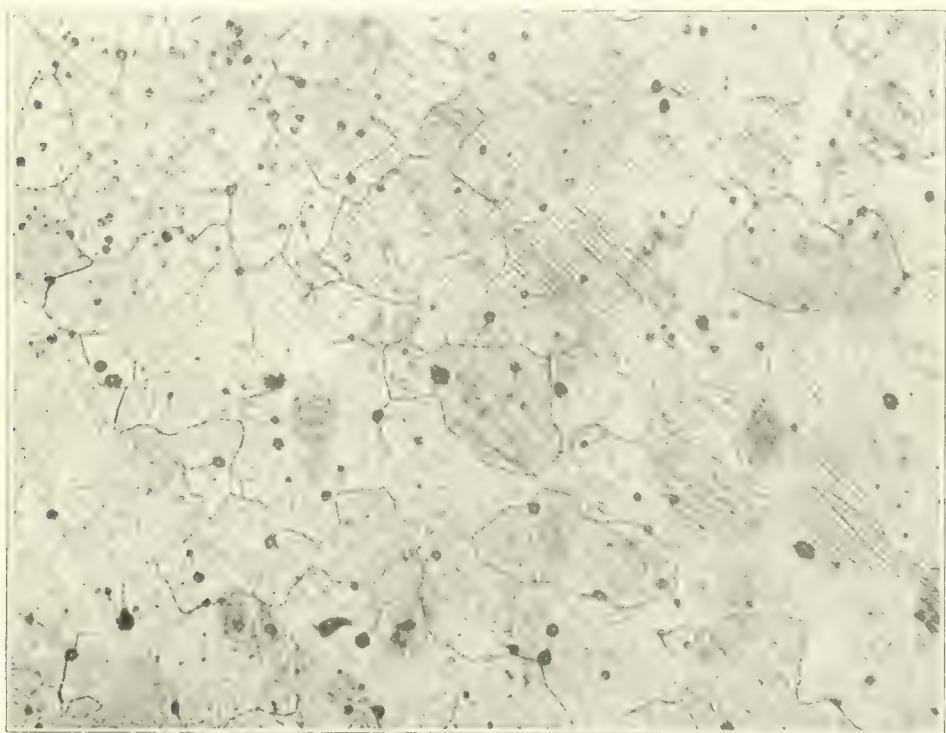


FIG. 6-A
NEWBURYPORT LINK FERRITE AND SOME SLAG

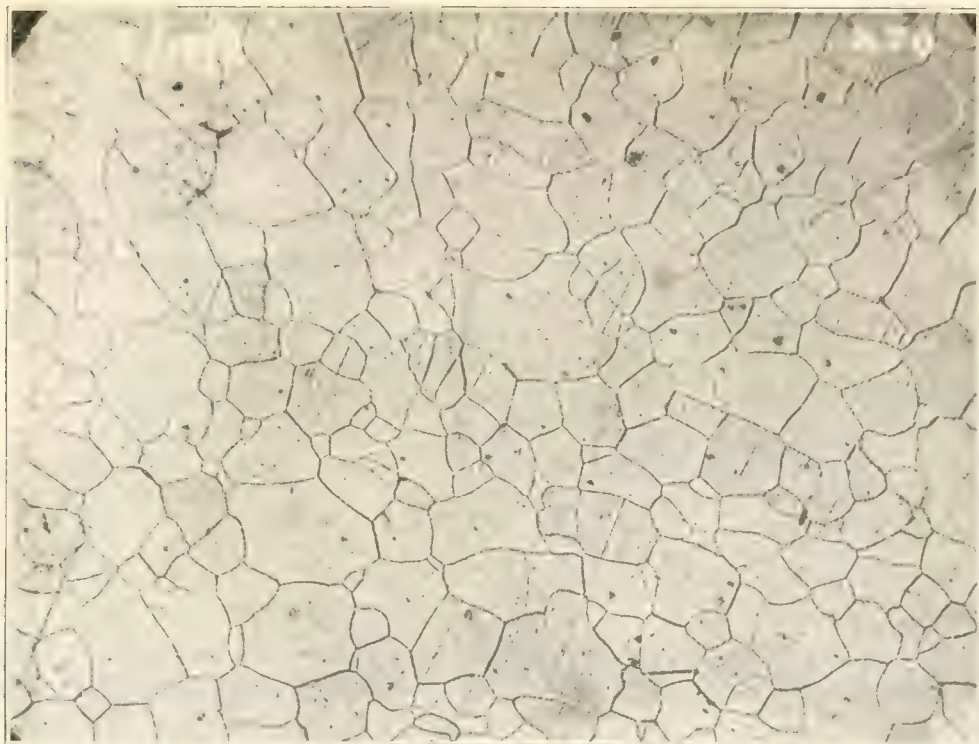


FIG. 6-b
AMERICAN INGOT IRON—CLEAR FERRITE—NO SLAG OR GASES

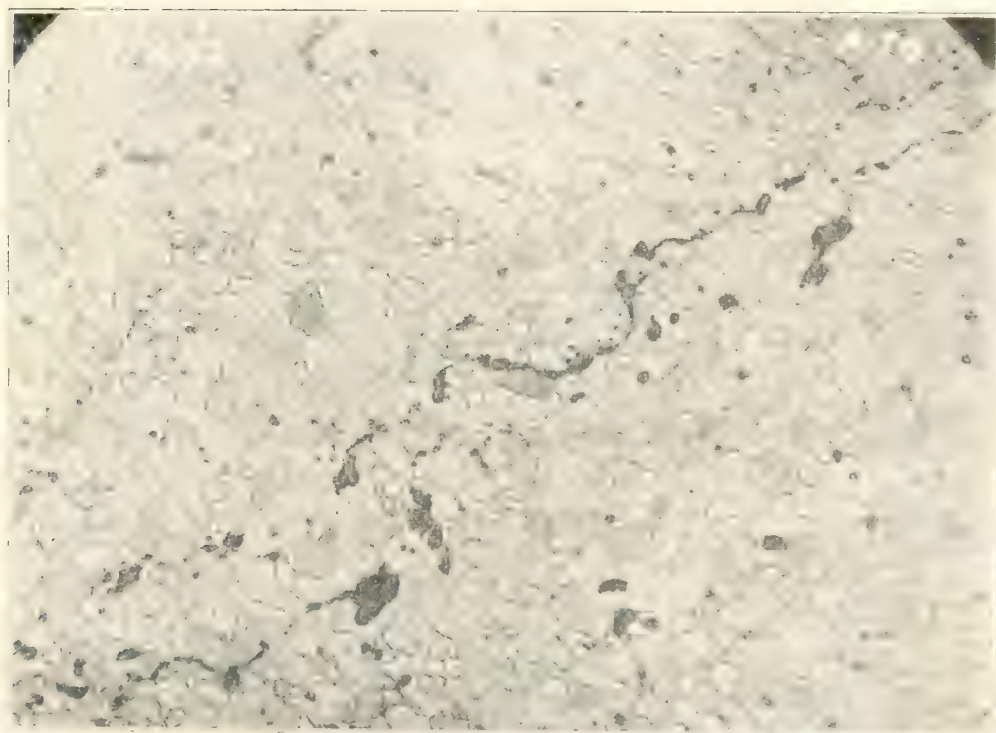


FIG. 6-c
STEEL GASES AND BLOW-HOLES

	American Ingot Iron. Per Cent.	Newburyport Link. Per Cent.
Sulphur	0.03 or below	0.006
Phosphorus	0.005	0.020
Carbon	0.010	0.040
Manganese	0.025	0.010
Silicon	0.005	0.028
Copper	0.030 or below	Trace to 0.43
Oxygen	0.030	0.030
Hydrogen	0.001	0.001
Nitrogen	0.004	0.003

A practical test made by disinterested parties and by a court of last resort is the Test Fence, erected in Atlantic City by the American Society for Testing Materials, in October, 1908; see Figs. 7, 7-A and 7-B. The Test Fence proves conclusively the value of American ingot iron over steel from a durability standpoint, and we call your attention to the pictures, which show clearly that American ingot iron is far superior to steel from a rust-resisting standpoint, as well as its power of holding paint.

I have endeavored to show how American ingot iron is manufactured, also its value from a rust-resisting standpoint, but I do not want you to feel that American ingot iron is a cure-all. This pure iron is not rust-proof; it rusts slowly, uniformly and evenly and is free from "pitting" or tubercular corrosion.

American ingot iron is soft, ductile and tough, and is guaranteed to contain less than 0.16 per cent of total impurities, classing as impurities, sulphur, phosphorus, carbon, manganese, silicon, copper, oxygen, hydrogen and nitrogen. American ingot iron is 99.84 per cent pure.

The physical properties are as follows:

Elastic limit	25,000 lbs. sq. in.
Tensile strength	42,000 lbs. sq. in.
Elongation in 8 in.....	25 per cent
Reduction of area.....	60 per cent

On account of its freedom of slag this pure iron can be bent and flanged in either direction without showing any signs of cracking. It will flange perfectly, but, like any other high grade product, the flanging temperatures must be understood and the iron worked accordingly. On account of its high purity, American ingot iron has a critical temperature, between 700 and 900 degrees Cent., viz., a dark cherry to a light cherry heat. This is called the critical range, and at this range of temperature the iron is apt to be brittle; all heavy flanging must be done at the high temperatures, viz., from the white heat to the orange color; light flanging can be successfully done at a dull red heat. If this method of procedure is followed no trouble will be experienced, and, in fact, an experienced flanger prefers to flange American ingot iron rather than steel, on account of its uniformity and its soft, pliable nature.



FIG. 7-B



FIG. 7-A

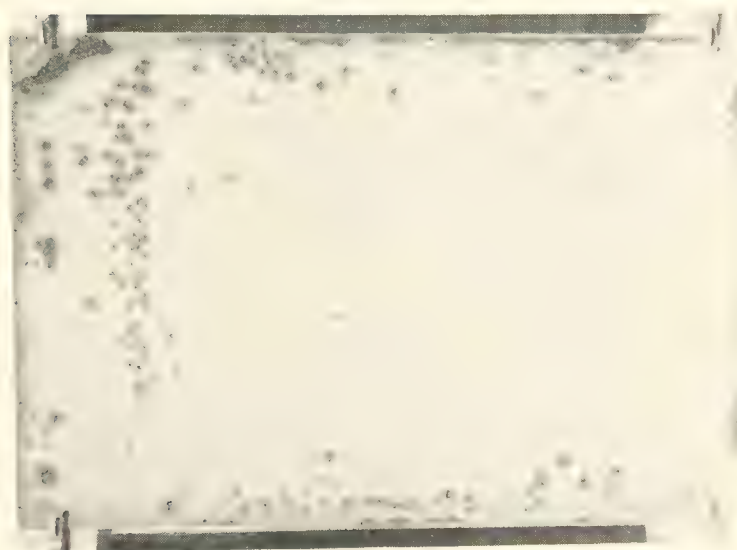


FIG. 7

It has been found that pure iron dissolves in molten spelter only one-fourth as rapidly as steel; consequently, the zinc does not become contaminated with as much dissolved iron when an iron sheet is galvanized. That purity of spelter is of great importance from a corrosive standpoint, has been proven, and tests show that the galvanized coating on American ingot iron will resist the action of sal ammoniac, ammonia, dilute hydrochloric acid and caustic acid or potash much better than the coating on steel. The most important point, however, is that the spelter coating on American ingot iron is from 200 per cent to 400 per cent more resistant to the action of boiling water than the spelter on steel; hence, not only is a pure iron base more rust-resisting, but also the coating applied to such a base is more durable. The slides shown of the Atlantic City Test Fence prove this also from a paint standpoint.

The facts set forth in this paper prove conclusively that purity in iron is essential from a rust-resisting standpoint. The manufacture and the successful handling of an iron which is almost chemically pure, in commercial quantities, is an accomplishment to be proud of and marks a new era in the iron and steel industry. This pure American ingot iron is being used in the manufacture of sheets, plates, roofing, terne plate, boiler tubes, rivets, metal lath, fence wire, nails, etc., and is without a doubt the purest and most rust-resisting iron ever made in this country or abroad.

The wise man recognizes that there are some places and conditions where iron or steel should not be used, but in all cases where iron or steel can be used within the limitations of the tensile strength of pure iron, viz., 40,000 to 44,000 pounds per square inch, and where the maximum resistance to corrosion is essential, American ingot iron is the best material obtainable.

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October 22, 1912.

Discussion

Question—MEMBER:—

In annealing these sheets and plates I would like to ask what method you employ to prevent oxidation?

Answer—MR. AHLBRANDT:—

The sheets and plates are placed on a large cast steel bottom plate. A hood is placed over same and iron oxide is placed around the edge of the hood in order to prevent any air from getting to these sheets. The carefully protected sheets and plates are then placed in the annealing furnace and the temperature brought up carefully. Since no air can enter the hood, you can readily see that the sheets and plates will be surrounded by a reducing atmosphere and hence no oxidation will take place.

Question—MEMBER:—

Is this annealing process used in the manufacture of steel?

Answer—MR. AHLBRANDT:—

Steel sheets are also annealed, but the annealing process is not carried out as carefully as in the manufacture of American ingot iron. The tendency of the steel sheet manufacturer is to reduce the annealing operation, because this is expensive. We have found that it is absolutely necessary to thoroughly anneal sheets and plates in order to take out the stresses and strains which the material receives in going through the mill.

Question—MEMBER:—

Can you tell us something of the advantages of the Duplex system?

Answer—MR. AHLBRANDT:—

I did not take up this phase of iron and steel manufacture, because time did not permit. The Duplex system consists in taking the hot molten pig iron direct from the blast furnace and placing same in a converter. Here silicon and a good portion of the phosphorus and carbon are eliminated by blowing air into the converter. When the carbon is burnt out to approximately 0.25 per cent the molten metal is charged into the open-hearth furnace, where it is further purified, and steel of the required analysis is produced. The Duplex system is very economical and is being successfully carried on by the Ensley plant of the Tennessee Coal & Iron Co., at Birmingham.

Question—MEMBER:—

The essential thing then in the manufacture of American ingot iron is to burn out all of the impurities?

Answer—MR. AHLBRANDT:—

Yes. The manufacture of American ingot iron is a process of elimination from start to finish. Not only is the sulphur, phosphorus, carbon, manganese, silicon and copper reduced to a

minimum, but also the occluded gases, such as oxygen, hydrogen and nitrogen, are carefully removed.

The manufacture of American ingot iron is similar to the manufacture of puddled iron, with the exception that the impurities in American ingot iron are eliminated while the iron is in the molten state. In this way all slag, as well as the other impurities, are removed. In the manufacture of puddled iron the impurities are removed while the iron is in the plastic condition, and hence the slag cannot be totally removed. In the days of puddled iron you remember you could buy a No. 1, a No. 2 and No. 3 refined iron. You always paid more for the No. 3 refined iron than you did for the No. 1 refined. Besides, the No. 3 refined contained less slag, which was due to the iron being worked more carefully. The No. 3 refined was also more resistant to corrosion. Hence, you can see that the slag content had no bearing on the rust-resisting properties of puddled iron. In the manufacture of American ingot iron the impurities, the gases and the slag are actually puddled out while the iron is in the molten state and the iron is not tapped from the furnace until it is almost chemically pure.

Question—MEMBER:—

Tell us what method you use to remove the oxygen gas.

Answer—MR. AHLBRANDT:—

The oxygen gas is removed by means of aluminum shot. The aluminum combines with the oxygen and forms aluminum oxide, which rises to the top of the bath and combines itself with the slag.

Question—MEMBER:—

At what stage of the operation are the gases removed?

Answer—MR. AHLBRANDT:—

The elimination of the gases is the last stage in the purification process. After all of the phosphorus, carbon and manganese are eliminated the gases are then removed by proper degasifying agents.

Question—MEMBER:—

Can you make a low copper content iron?

Answer—MR. AHLBRANDT:—

This is a very important point and I am glad same was brought up. It is not possible to eliminate copper and hence the manufacture of a low copper content iron necessitates the use of high grade raw material, viz., pig iron with an exceedingly low copper content. This eliminates the use of borings and turnings, because such scrap always contains copper, babbitt metal, etc. Hence, by specifying a low copper content iron, you will force the manufacturer to use high grade selected raw material. We are manufacturing American ingot iron with a copper content of 0.03 or under.

Question—MEMBER:—

Is it necessary to degasify steel ingots? I ask this question particularly because of the discussion that is being carried on in regard to this point. A great deal has been said in the last few years in apparent efforts to eliminate this gas and sometimes the ingots are subjected to hydraulic pressure. Now the pertinent question is, is there any reasonably cheap and practical method which will eliminate these gases?

Answer—MR. AHLBRANDT:—

Yes. It is absolutely necessary to degasify steel. This should be done before the material is in the ingot form, viz., the degasification should be carried on in the furnace and while the molten metal is running into the ladle. The gases are eliminated by such elements as titanium, aluminum, etc. It is absolutely necessary that all steel and iron be thoroughly degasified in order to obtain a dense, homogeneous structure throughout. In the manufacture of American ingot iron we determine whether the iron has been thoroughly degasified by two methods. In the first place, a definite chemical analysis is made for oxygen, hydrogen and nitrogen gases. This is done on every heat of iron that is poured. Another and simpler method is to saw an ingot in two and examine the structure. If blow holes appear around the edge of the ingot, this is an indication that the material is full of gas, and hence the metal is not fit for use, but should be remelted and properly degasified. This method of procedure is carried out thoroughly in the manufacture of American ingot iron.

Question—MEMBER:—

What do you know about the so-called Toncan metal?

Answer—MR. AHLBRANDT:—

Toncan metal is an imitation of American ingot iron. I have analyzed a good many samples of Toncan metal, and in some cases this material analyzes equally as good as American ingot iron when considering the sulphur, phosphorus, carbon, manganese and silicon contents, but in all cases the analysis of Toncan metal showed that the degasification process had not been carried on to the extent that it should be.

Question—MEMBER:—

I would like to ask if any tests were made on the tensile strength of the Newburyport links?

Answer—MR. AHLBRANDT:—

Yes. The tensile strength of the Newburyport links are somewhat higher than puddled iron. They averaged about 40,000 pounds per square inch in tension.

Question—MEMBER:—

What percentage of ferrite was found in the Newburyport links?

Answer—MR. AHLBRANDT:—

The average ferrite content of the Newburyport links is 99.86 per cent. This takes into consideration the following impurities: Sulphur, phosphorus, carbon, manganese, silicon, copper, oxygen, hydrogen and nitrogen contents.

Question—MEMBER:—

Tell us something about the difference in structure of steel, puddled iron and American ingot iron.

Answer—MR. AHLBRANDT:—

The structure of steel, as we all know, is crystalline. The structure of puddled iron is fibrous, and the structure of American ingot iron is silky in nature. This can be readily distinguished under a microscope.

Question—MEMBER:—

Why not use American ingot iron for eye beams, channels, etc.?

Answer—MR. AHLBRANDT:—

I do not believe it would be advisable to recommend American ingot iron for eye beams, channels, etc. By eliminating the impurities we increase the rust-resisting properties, but we decrease the physical properties somewhat. Hence, American ingot iron is not a cure-all. Where resistance to corrosion is of paramount importance and strength of secondary consideration, American ingot iron should be used. The tensile strength of American ingot iron is approximately 44,000 pounds per square inch, while the tensile strength of mild steel is 55,000 pounds per square inch. Hence, where strength is of more importance than durability, mild steel should be used. When the government decided to use American ingot iron plates in the construction of the Uncompahgre Valley pipe line, it was necessary to increase the thickness of the plates in order to take care of the internal pressure.

Question—MEMBER:—

What can you say about the action of chlorine on American ingot iron?

Answer—MR. AHLBRANDT:—

Several tests have been made along this line and it has been found that American ingot iron will withstand the action of chlorine gas far better than steel.

Question—MEMBER:—

What do you consider the best preservative coating?

Answer—MR. AHLBRANDT:—

This is a rather difficult question to answer. Up to the present time a zinc coating is the best coating we can apply to a sheet of either iron or steel.

Question—MEMBER:—

What do you know about galvanic paint?

Answer—MR. AHLBRANDT:—

I am not acquainted with it. I might say that the best paint on the Atlantic City Test Fence is proving itself to be American vermilion. This is a red paint, similar in character to the paint used by the Pennsylvania railroad.

Question—MEMBER:—

In regard to the three plates which were placed in comparison on the Atlantic City Test Fence, viz., American ingot iron, Bessemer steel and open-hearth steel, how soon after these plates left the plant was the paint applied?

Answer—MR. AHLBRANDT:—

I believe there were set rules in regard to applying the paint on all the panels placed on this Test Fence. This information can be obtained by writing to Mr. Henry Gardner, Institute of Industrial Research, Washington D. C.

Question—MEMBER:—

How does ingot iron compare with steel for the manufacture of metal lath? Will black American ingot iron lath last as long as galvanized steel lath?

Answer—MR. AHLBRANDT:—

This is a very good question. American ingot iron can be used and, in fact, is being used in the construction of expanded metal lath. Hence, we are safe in saying that from a manufacturing standpoint no trouble will be encountered in the use of American ingot iron for metal lath purposes.

It is hardly fair to compare the durability of black American ingot iron lath with galvanized steel, and I am not in position to give you any actual service tests. Galvanized steel lath, however, unless it is galvanized after it has been expanded, cannot be depended upon from a durability standpoint, because the raw edges of the steel would be exposed and eaten away rapidly. A good many patent plasters are on the market today, which contain hair, glue and other organic compounds, and it has been found that when this plaster absorbs moisture, the organic acids which are formed are very severe on the life of metal lath. A pure iron lath, such as American ingot iron lath, will resist this deteriorating action far better than steel. Besides this, the organic acids would very quickly dissolve any galvanized coating. Hence, my belief is that pure iron lath would last even longer than a galvanized steel lath.

Question—MEMBER:—

Have you made any tests with concrete and American ingot iron?

Answer—MR. AHLBRANDT:—

I have made no tests on this subject. My belief is that if concrete is properly mixed, no trouble will be encountered, whether you use steel or pure iron. Government reports show that if the concrete is free from all voids, no serious deteriorating action will occur.

Question—MEMBER:—

What is the guaranteed purity of American ingot iron and the complete chemical analysis?

Answer—MR. AHLBRANDT:—

This is a good point. American ingot iron is guaranteed to contain not over 0.16 of 1 per cent of total impurities, taking into consideration the sulphur, phosphorus, carbon, manganese, silicon, copper, oxygen, hydrogen and nitrogen contents. The guaranteed chemical analysis is as follows:

Sulphur	0.020	per cent
Phosphorus	0.005	per cent
Carbon	0.010	per cent
Manganese	0.025	per cent
Silicon	0.005	per cent
Copper	0.060	per cent
Oxygen	0.030	per cent
Nitrogen	0.004	per cent
Hydrogen	0.001	per cent
	0.160	per cent
Iron	99.840	per cent
Total	100.000	per cent

Question—MEMBER:—

How does the cost of American ingot iron compare with that of steel?

Answer—MR. AHLBRANDT:—

This is a good question. It is absolutely necessary to consider the element of cost. American ingot iron costs approximately 30 per cent more than steel and will last from two to three times as long as steel under the same conditions. Actual service tests have proven this. When you consider that the cost of the sheets and plates used in the construction of any article is a very small part of the total cost of this article, you can readily see that it behooves us to use the best material we can obtain for this purpose, especially when the life of same is materially increased.

Question—MEMBER:—

Will your American ingot iron plates resist the action of water as well as steel?

Answer—MR. AHLBRANDT:—

Are you speaking of friction or durability?

Question—MEMBER:—

Friction.

Answer—MR. AHLBRANDT:—

No definite service tests have been conducted along this line, but I see no reason why American ingot iron would not resist the friction of water as well as steel.

INGOT IRON VERSUS STEEL.

- American Society for Testing Materials.** Proceedings 1911, v. 11, p. 387-408—The manufacture of pure irons in open-hearth furnaces, by A. S. Cushman. An account of a method of manufacture of what is regarded as a new iron with great resistance to corrosion. Abstracts in *Iron Age*, July 13, 1911, and in *Iron Trade Review*, July 6, 1911.
- Boiler Maker**, Jan., 1912—Pittsburgh pure brand of American uniform ingot iron, by H. M. Feldmann. Read before the American Institute of Steam Boiler Inspectors. Information concerning this material and its non-corrosive qualities.
- Engineering News**, Jan. 6, 1910—A new process in iron metallurgy; slow-rusting iron produced in the open-hearth furnace. Describes the ingot iron produced recently at Middletown, Ohio; the evolution and results of the process.
- Engineering Record**, July 1, 1911—The elastic properties of American ingot iron, by E. L. Hancock. Reports results of a study of its physical properties, especially its recovery from overstrain.
- Iron Age**, Feb. 24, 1910—Patents on dead soft open-hearth steel, or "ingot iron."
- Iron Trade Review**, Dec. 9, 1909. A new rust resisting iron: A product of the ordinary open-hearth furnace showing remarkable purity. Describes the characteristics of ingot iron and its manufacture by the American Rolling Mill Co.
- Aug. 31, Sept. 7, 14, 1911—The new plant of the American Rolling Mill Co.
- Sept. 12, 1912—What is steel? Other definitions of soft steel. From report of Proceedings of the Sixth International Testing Congress. Discussion on whether ingot iron does not more nearly approach steel than iron.
- Railway Age Gazette**, Sept. 30, 1910—American ingot iron: Its development and production, by G. L. Fowler. Describes the development of the process and present practice of manufacture, explaining its properties and its demonstration of the probable truth of the electrolytic theory of corrosion.

Apprenticeship Systems and Co-operative Schools in the United States

BY PROF. JAMES F. BARKER.

In the early organization of industry, the vocation of the father was handed down through the family from generation to generation. It is from this source that many of us have derived our family names. The Sellers, the Beyers, the Carpenters, the Masons, the Tanners, the Barkers have all derived their names in this way. In medieval times the sons of the family were not sufficient in number to keep pace with the growing demand of industry and a system of apprenticeship gradually took the place of the old family industry. Each master had a few apprentices, who in time became journeymen and later masters themselves. The usual time for service was about six years. During this time the apprentice was bound over to his employer and was forced to serve the entire term of indenture. Out of this system sprung the guilds of the middle ages which have reappeared in our organized labor unions of today. But the old Guild system did not serve to stratify society as we have come to know it in modern times.

The apprentice on finishing his term of service frequently would undergo an initiation before he was finally admitted to his Guild. A very high standard of workmanship and of social ethics was maintained by the old members of these Guilds. A man who undersold his brothers in the craft was immediately in disrepute. Therefore, men sought to gain trade by the quality of their goods rather than by their cheapness. This led to keeping secret the methods of many trades, and processes and arts were thereby lost. For instance, we are unable today to duplicate the red colors of the Pompeians. It is believed that the Egyptians knew much of denistry and some of the methods of engineering with which we are today unacquainted.

It may not be without interest to you to know that the word indenture refers to the way in which the papers of an apprentice were cut or indented, so that both halves of the contract could be fitted together for purposes of identification. The system of apprenticeship involved in itself the teaching of a trade in its entirety, and the medievals herein developed the most elaborate and perfect system of industrial and vocational education that the world has ever known. But with the perfection of machinery and the elaboration of mechanical processes, the cost of tools became so high that the small master mechanic could not maintain his position as industries grew in magnitude. It, therefore, became impossible for the apprentice to look forward to the time when he would be a master workman with other workmen learning the trade, as apprentices, from him. Manufacture, as con-

ducted today, is too expensive in its outlay in equipment for the Guild system to exist. Under the old plan, the industries were adequately supplied with skilled artisans and there was formerly no need of any training for skill beyond this. Our old system of schools presupposed that the boy would get his vocational training elsewhere, and that this condition would continue. Our modern schools are based upon the same theory and have made no provision for furnishing an education which will supply this deficiency. In this connection you will find an interesting article beginning on page 14 of Bulletin No. 6 for 1908 of the Bureau of Education, by Carrol D. Wright, on "The Origin of the American System of Apprentices". With the transplanting of the English industries to the American Colonies the old practices of the English Guilds were brought to this country. Until the beginning of the nineteenth century the conditions of apprentices were not worse than they had been in the European countries, but with the rapid growth and development of American manufacturing, abuses soon arose to such an extent that up to 1840 apprenticeship systems were only another name or form of slavery, a method of securing boy labor for a very small compensation. In 1860, laws were passed by various states compelling employers to teach the whole trade. There had been no limitation of apprentices, but shortly after 1870 the labor unions sought legislation limiting the number of apprentices in an effort to curtail the supply of skilled labor.

One often hears nowadays that the apprenticeship system in the United States has been dead for twenty or thirty years. I do not believe that this is borne out by facts. *The American Machinist*, in 1906, made an inquiry relative to the existence of apprenticeship systems and the majority of firms so questioned replied that they maintained a system of apprenticeship in some form or another. Dr. Howe, of Case School of Applied Science, made an inquiry of firms in Ohio and found that not many concerns were maintaining systems of apprenticeship wherein all of the trade was taught to apprentices, though some form of apprenticeship was in existence in a number of factories and employers have realized that employes are not learning the whole trade as apprentices and that there is at present no source of skilled labor. To supply this need, various types of schools have arisen. One of the first established in the day time was that founded by the Building Trades Association in Chicago. They collected a number of apprentices during the slack season, and established a school, where the boys could still be educated in the parts of their trade in which they received no education during the rest of the year, so that these apprentices, who were bound over to their employers, were taught all of their trade. Thus, in Chicago, an effort was made, some fifteen years ago, to take care of the boys engaged in the building trades and give them some sort of a trade education. Now a great many of our trades today, are realizing the need of this same training. The Baldwin Locomotive shop maintains an apprenticeship school, and divides its pupils into four classes, from fourteen to eighteen years of age. There are divisions for those who have finished grammar school,

for those who have attended the high school part time, for high school graduates, and even for those who have graduated from college.

The Allis-Chalmers Co., of Milwaukee, large employers of skilled labor, are making some effort to educate their men in day time. The Brown & Sharpe Co. maintains a school for their apprentices. In Wisconsin they are doing more than in any other state that I know of, and have recently passed a state law in the interest of apprentices.

Today, the duties of a boy beginning as an apprentice are those of a chore boy. We investigated some cases of our own graduates and found that in a certain pattern-making company the apprentice boy was set to sweeping out the rooms and like odd jobs. And that is the experience of most apprentices. Not much of the trade is learned by this process. I dare say that a great many of you know that nearly all apprentices get pretty much the same treatment, and if a boy is to get his trade, he must get it hit or miss. Very often he gets it by changing jobs frequently, and yet that is about the only way now-a-days that he can learn his trade in its entirety. The beginner goes to a shop where he will be given only a certain kind of work, then he goes to another shop and says that he is experienced (it may have been sweeping the floor) and he gets a better job. Later he seeks another place, and he is set at something a little higher in the trade. He must acquire his trade by the stealing process and by changing his place of employment to get the opportunity.

In the United States we have been making a number of efforts to overcome this condition. A wealthy Philadelphian established a school just outside of his native city, The Williamson Free School of Trades. Mr. Williamson stipulated that when a boy came to the school he must be a poor boy and if he was well enough off to pay his way he ought not to be admitted. The applicant must be an intelligent pupil, but he must be a poor boy. Here he is given three years of training in the trade. But in addition to that a boy who is to be a good master workman must have training in English, in mathematics and in the sciences. The boys who enter the Williamson school are indentured, and when they appear before the men who determine their fitness for certain vocations, they are assigned to different departments and have very little freedom of choice. The boys are assigned to the trade according to the best judgment of the directors of the school, who determine the matter of the apprentice's trade. This determining a boy's trade for him is somewhat like the German plan.

In another direction, an effort to supplement the apprenticeship system has been made in the University of Cincinnati. Here, they are trying the part time school. The University maintains an engineering course and the boys who wish to enter are allowed to give six years to their engineering education, but must work half time in the shop and half time at their formal education; this is the highest type of industrial education; it is, however, plainly for engineers and not for journeymen workmen, or the so-called industrial unit, the workman. It may be interesting to inquire into the remarkable success of this plan. A much larger

number apply than can be cared for. A plan of careful selections secures the very best possible material. If we could, out of 800 boys, pick 200 of the best, we probably could secure excellent results in any part time school. But, we have to take what comes to the school and so does the employer in selecting his apprentices.

Fitchburg has a part time plan in operation. It is a plan for the boys who have reached high school. The boys who wish to enter the trade course here established, first get a job in one of the factories of Fitchburg, then they may go to the high school and take part time instruction related to the trade in which each one is interested. The factory must run continuously so the apprentice has an alternate, another boy who takes his place at the shop, and likewise when he goes to school, so that both get instruction in the trade and in the school week about. In this town the industry is largely that of manufacture of machine tools and the school has met with marked success.

But, under this plan, the employer determines whom he shall employ, and this is undemocratic and not the final nor the best solution of the problem of vocational training for apprentices. Here a boy, to get a trade education, must first secure trade employment, and trade education, though public, is not open to all. The same is true of the textile schools, in Lowell, in Bedford and in other places. A municipality must offer equal opportunity to everyone and shall not say to the employer, "You may determine who shall receive this training."

In Ludlow, Massachusetts, is a school where the boys remain three hours out of the factory, in school, but get pay for the time spent there. I am calling your attention to all these kinds of schools because they are various phases of the effort of our educational system to furnish the training in manipulative skill that it is perfectly evident to every employer, is lacking among the workers in the great manufacturing industries of the United States.

The printers in Boston realized that their industry was suffering in that city and that if Boston was to remain a printing center, they must give special training to their apprentices. At the North End Union, therefore, a school was started in the printing trade. The boys are indentured for a term of years and must pay tuition.

We have been making some effort here in Cleveland in night school to give factory boys an education related to their daily occupations. The sheet metal workers asked if they could have a school for boys who were working as apprentices at that trade. We have been able to offer them instruction related to sheet metal working under teachers who are sheet metal workers and draftsmen, and who are at the trade in the working hours of the day. This is the true type of continuation school.

Many states are appointing commissions to look into the feasibility of offering trade training to their boys and girls. Some states have already taken action; New York, New Jersey, Illinois, Indiana and Wisconsin are perhaps the most progressive. In the city of Cleveland we have come to believe that some instruction

in academic subjects must be joined with instruction in the trade. This instruction may be in science, history and mathematics.

In Chicago, where some experience has been had with apprentice schools, if you will reduce the cost of instruction to a ten months basis for the usual school hours per day, the cost per capita has been \$42.40—the actual cost has been much less than this, because the schools have only operated during the winter. In the elementary schools the per capita cost has been \$25.25 for technical training, and in the Chicago vocational high schools it has been a little over \$70.00 per capita.

The General Electric Co. have an apprentice school, in which boys are trained for the General Electric Co.'s plants. It is said that the company have made a profit on their school. Their plan is to take boys, whom they think would make good employes for them, and give them instruction in several branches that are related to the industry in question. The one who instructs them in the shop also gives them arithmetic and instruction in other related subjects. The result has been that a large number of boys have applied to them for employment and they have been able to pick out some exceptionally bright ones. They have been able to select from a large number, and the small number that were particularly useful to their needs have been retained. The union has charged that the school has been solely a money-making proposition and that the apprentices have been exploited. On the other hand, employers have said, "If we take a boy from the street and instead of making him a chore boy, who sweeps the shop, we make a first class mechanic out of him and give him schooling at our own expense, even though we are directly benefited thereby, we have rendered the community a distinct service." There are a good many of these factory schools in various places; the New York Central railroad, the Baldwin Locomotive Works, the Westinghouse Electric & Manufacturing Co., and many other firms, are maintaining such schools. The General Electric Co. hold yearly examinations to ascertain whether their pupils shall go from one class to another, or from one position to another. Frequently they in turn make these boys teachers.

The difficulty, however, with all of these schools is that they are too narrow in their limitations. For instance, in the New York Central schools the boys are taught what they need to know for the benefit of the New York Central railroad, and this is much better than no instruction. But a system which is to be the best system obtainable must be based upon a very much broader foundation than any of the systems now existing.

One of the best examples of apprenticeship schools as they should be is found right here, in Cleveland. It is the system that is maintained by the Warner & Swasey Co. This company indentures a boy for four years. They wish to train a boy for their own special purpose. They want him to know everything about the Warner & Swasey system; their contract is interesting to us, because it reserves the right to look after the boy's moral welfare as well as his progress in the trade, and they reserve the right to dismiss the apprentice at any time if he does not measure up to their standard of morality. They give their boy six months'

trial, and then he is engaged as a regular apprentice. From there on they have a sliding scale that runs from 8 to 15 cents an hour. In all, there are four terms. At the end of the last one, the boy gets \$100.00 bonus, and a certificate that he is graduated from their course. They reserve the right to dismiss a boy for want of proper capacity, for non-attendance to his duties, and for improper conduct. A system such as this, where all phases of the industry are taught, where education is offered on a broad basis, will do much to improve the apprentice, and it will eliminate most of the faults of all heretofore existing systems. Had the trade unions sought to revive the spirit of the guilds, instead of confining their efforts to improvement in wages and hours alone, something might have been accomplished long ere this. In Austria and Hungary they have sought to revive the old guilds, but the movement has not met with success, and I do not believe a similar plan would be successful here. Our labor unions are not in any way like the old guilds. A good system of apprenticeship will be better than the system of the guilds ever was, but I believe schools which are maintained for a selected few are a menace to the democracy of the country and a school which is selective, and that is the case of the General Electric Co., that is, this company determines which boys shall receive an education, and in so doing is exercising an unwarranted prerogative in a democratic country. I believe that the apprenticeship system, coupled with public education, is the only proper solution of this problem. I think it is the duty of the public schools to give the trade education to boys and girls; an education in which parents can see a direct bearing upon the earning capacity of their children. The professions have their wants supplied; the architects and engineers have schools and colleges for the training of the members of their profession. Why do we provide professional training and neglect trade education?

Nearly all of the states have apprenticeship laws, which have school laws embodied in them, but in most states these laws are ineffective, because they have never been enforced. The apprentice doubtless needs protection during the time of his indenture, and for that reason Illinois recently passed a law that in all municipalities where such indentures are made, it shall be the duty of the master to cause the apprentice to attend school at least three consecutive months each year, without cost to the pupil. In the school to which I referred in Chicago, established by the Building Trades Association, for apprentices, the boys are paid a better rate when at school than other boys are paid when they work in the summer. And in a number of places boys taken from work to attend school are paid the same as though they were at work.

Wisconsin has recently passed some very interesting legislation along this line. Their law is interesting in this connection, in that it states that any city wishing to establish vocational education or training for apprentices may do so provided the Board of Education, which is regularly elected, will elect two employers, two employes and the Superintendent of Schools, who shall constitute a separate Board of Education with the right to levy taxes,

to issue bonds, and to establish schools in which apprentices may receive instruction in their trade. I think perhaps that this is wise, because it insures interest and progress, something which regular Boards of Education have not always shown. The employer, the employee, together with the Superintendent of Schools, will be interested in furthering the movement and I think we will have worked out there something that will be well worthy of emulation in other states.

Massachusetts has been seeking to solve the problem of vocational education, and New Jersey has been at it even longer, but Wisconsin has perhaps done the most in this direction. In Wisconsin the law gives the right to the employer to fine the apprentice if he does not go to school; there shall be no indenture of less than one year; the whole trade shall be taught; and for two hours a week business, English, physiology, hygiene, arithmetic and the use of safety appliances shall also be taught. The employers who meet these requirements may keep apprentices; they will lose these privileges if their employees do not come up to a standard requirement. The employers, it is reported from Wisconsin, have been willing to send their boys in Milwaukee and Racine to schools there provided, and to pay them the regular wage while they are in school.

In Cincinnati continuation schools have been in operation for some time. There the schools have been so organized that the boys who are in the machinist trade receive instruction part time each week in school.

They leave their machine and receive instruction that is directly related to the work they have to do in the day time. The teachers in charge visit the shops and find out what are the needs of the shop and the instruction which is necessary is then given in the school. The first school, originally organized under Mr. J. H. Renshaw, was taken over, about a year and a half ago, by the city of Cincinnati, and is now being maintained at the public expense. Do not confound this continuation school with the school maintained by the University of Cincinnati, which is an engineering school. Every man who is to enter a trade, however, needs training before he is indentured. Apprentices cannot be indentured under the law in most states until after they are 16. What shall we do for vocational education in the pre-apprentice period?

The city of Boston has been making some efforts to provide some pre-vocational training and has established a school in the sixth, seventh and eighth grades, where instruction is given one-half time in vocational subjects. This type of instruction is so arranged that it will lead to high school as well as to apprenticeship and a boy has the opportunity to change his plan and may be admitted to the high school, even though he has given only half of his time to academic instruction in the sixth, seventh and eighth grades; that is, the industrial education has been so planned that it will be of sufficient value to equal the instruction, where all the time is given to academic subjects in these grades. The same plan is being tried out in New York City.

We have had evening schools; we have had continuation

schools of the German type; we have had part time schools, the private schools and correspondence schools; the Y. M. C. A., and I believe that we are about to have the publicly maintained vocational or trade school. I do not believe that the corporation school is the solution of the problem. I do not think the continuation school is the answer to our difficulty, and I am sure the night school is not. The corporation school is selective and undemocratic. I believe the only way we can work out this problem will be in the public trade schools. This type of school can only come to us when we have labor laws limiting the employment of boys and girls under 16 years of age, to 45 hours per week. The continuation school meets with opposition from the employer and it will continue to do so as long as the law allows the employes to profit by child labor. First we must have the continuation school; we must have the corporation school; these are the necessary steps; but I believe eventually that we must come to the publicly maintained trade school, where the entire trade will be taught.

Both manufacturers and labor leaders will tell you that you cannot reproduce in a school the conditions in a manufacturing plant; that it is the lack of commercialism and the lack of the speed element in finishing the product in the factory that cannot be duplicated in the school. We can, however, teach all the processes, and the student will get speed when he goes to the shop if he has been trained in the science of the process and given sufficient schooling so that he can earn a wage when he starts.

As labor-saving devices are perfected, the time of men required to produce a sufficient supply of a given article should decrease and the time left for self-improvement and recreation should increase; then, too, the beginning of the period of productiveness can be deferred so that in the future we may hope to have more time available for education. But, this education must function in life or it will not be of lasting value. As we view the number of hours of labor for the working classes during the past 50 years, we will note a steady decrease. I believe that in the future the hours for apprentices will likewise be lessened. With this lessening of the time given to industry, there must come a higher requirement along the lines of preparation for industry. Even now, in Ohio, five to eight hours per week may be devoted to continuation school instruction for boys and girls under 16 years of age. As we progress and the educators learn how to apply education to industry, the continuation school will be able to give the apprentice the needed instruction in his trade, which now we are failing to furnish. All education is uplifting and with the newer education will come better workmen and better pay and the manufacturer will be able to secure competent help with which to carry forward our industries.

Discussion

MR. J. W. LUTHE:—

We all acknowledge that what Professor Barker said in regard to the trade schools is a fact. I agree with him fully

about the corporations and the various systems, and the states that have adopted a system of manual training. If you look up the statistics, you will find that the building industry is very large, but it is wholly neglected. The boy cannot learn the trade, because the conditions are different from what they were. He cannot learn the trade from the employer, and if it cannot be taught by him, then it must be done at the expense of the state or the private pocket.

PROF. F. H. VOSE:—

I have not given this phase of the subject any particular attention; that is, the education of the young man or boy before he becomes eighteen years of age. I want to commend Professor Barker on the broad view he has taken of this subject. It is my honest belief that the solution of this problem will be obtained by placing it in the hands of the public; that is, that the public must stand the expense of the maintenance of this type of school. It is perfectly natural that so long as the employer has to pay the costs of these trade schools, he will exercise the right to say who shall attend.

I was much interested in what Professor Barker said in connection with the schools in Boston; that they allowed the students, for a certain number of years, to spend at least half time in training for the trades, and then if they chose they could go on with the high school work, and that it had been demonstrated that this work was sufficient to equip the student to go on with the higher education. Some one has made the remark that education is not fit for much unless it teaches a boy to work. This training establishes the proper attitude in the mind of the student, and I believe that this trade system, even though he does not intend to follow it, gives him the right attitude. If you get a boy's heart right, he will take care of himself. The earlier we can get hold of a boy during his course in the engineering school and give him the right professional attitude, the better graduate we will turn out.

MR. A. J. HIMES:—

I do want to say one thing in regard to the learning of trades. We have talked a great deal at different times, and much has been written about the reasons why we do not have a continued influx of skilled labor from the younger ranks of society. It seems true that we do not. I hear no opposition to that idea. I have seen much of it personally. Now, we have talked mostly about ways and means for supplying instruction to the young. It seems to me that the real secret of the difficulty is that the young do not want to be tradesmen; that their ideas are turned in other directions. They are not interested in the work of their forefathers; they want to do something else, and I would say that the primary step towards renewing the supply of skilled labor is to hold up before the mind of the public the achievements, the good work that has been done in the past by good artisans. I think we all need ideals. We all work best when we have before our minds the achievement of some person who, to us, appears in

the light of a hero. I think that is the fundamental human point of view, and if the time shall come when the work of a master painter, a master carpenter, a master mason, or a structural iron worker shall be pointed out with praise, something that is exceptionally well done, I think the younger generation will listen attentively and think about it and be inspired to go and do likewise. Perhaps I have not said this in a convincing way. Perhaps you do not agree with that idea. But I have observed things of that sort for many years in varied characters, and I have read much about it. I think that the idea has been expressed more directly and with more force by Dr. Bailey, of Cornell University, who has pointed out the foolish idea of thinking that we might maintain the farms throughout the land, when in all the public schools the attention of the child is turned continually towards the cities and away from the farms, when his attention is turned continually to the achievements of the great men, who have gone to the cities, lawyers, preachers, merchants, politicians and policemen, with the result that the farms in the New England states have become depopulated. Dr. Bailey's idea is to teach the child of the country the things of the farm, to show how riches may be derived from the soil. And in this work he has achieved very wonderful success.

I would use this work of Dr. Bailey as an illustration of a means which we might pursue to arrive at the desired end, a means of stimulating the building industry, of restoring our supply of artisans. I am not gifted, as is Dean Bailey, with oratory, and enthusiasm, which inspires an audience to rise up and carry out his ideas. I can only present it for your thought and consideration.

I would say further that I wish to commend to you for most careful consideration the words of Professor Barker. A couple of years ago, we were doing some very difficult work in erecting a bridge over Euclid avenue, out at Lake View. We had heavy girders (they weighed seventy-nine tons apiece) that had to be placed in position while both street cars and trains were running, automobiles and pedestrians were going under the bridge. The man in charge of that work was a strong, athletic man. He stood near the work, watching it very attentively, when a bystander said to him: "What if that should fall?" He looked around very quickly and looked again at the work and said: "It is not going to fall." He knew his art. He not only knew his art, but he knew that he knew his art. There was no disaster, everything went along with great success. I think Professor Barker is that kind of man. I think that he knows, and he knows that he knows. When he advances a theory, he expects some opposition. He is cautious. He does not announce it as a fact, and that in itself stamps him as a capable, considerate man.

I have had occasion to give some little attention to the Technical High School. There are some things about it which are very wonderful. It has a capacity of twelve hundred. It is accommodating sixteen hundred.

When I went to Cornell University, there were four hundred students. When I was graduated, there were eight hundred.

In that one building on Fifty-fifth street, over which Professor Barker presides, there are twelve to sixteen hundred pupils daily. He exercises daily control over those pupils. He has more complete authority over those young animals, you might call them, than was ever exercised at Cornell University. I don't know how he does it, but I know that those pupils have for him the highest respect; they think a great deal of Professor Barker. His word is law. They do not dispute what he says. They understand they must do as he wishes.

I cannot speak to you from the standpoint of an educator. My experience has been that of an employer and the father of children. One of my children entered the first freshman class of the Technical High School. He is now entering Case. He has had a most excellent training. I think he will have a better education than he would have had if he had not secured what he did in the Technical High School. And I think that our Society is to be greatly congratulated in being able to have with us the man who administers the affairs of that school, to tell us about its work and to give us first hand some of the best information on the subject which is available in the United States.

SUPERINTENDENT J. M. H. FREDERICK:—

When I came here this evening, I certainly had no thought of saying anything on this subject. The fact of the matter is, I have had no time to give to it. I should like to ask Professor Barker, however, how the Illinois law works out where the apprentice is allowed three months absence.

PROFESSOR J. F. BARKER:—

The law has not been enforced. It, like so many of our apprentice laws, has never been enforced.

SUPERINTENDENT J. M. H. FREDERICK:—

That is the question that comes to my mind. At a recent conference a number of employers were invited to meet some of the people at school headquarters to consider the question of the continuation schools. We have found that some employers, instead of sending the children from fourteen to sixteen years to the continuation school for one day of each week, simply gave us a chance to have them all the days of the week. Their contention was that business is business. People do not go into business for their health. They go there for profit, primarily, and if they find that they can employ a boy or girl six days a week to greater profit than five days a week, they are going to do what you or I or any other person would do. The law in this state permits a board of education to establish continuation schools; and children from fourteen to sixteen years of age, who have not completed the eighth grade, may be required to attend a continuation school, not to exceed eight hours per week. In Cleveland, the Board of Education, about a year ago, decided to establish such a school. Judge Addams says that it is a complete failure here, because these young people do not get the best places; they have to take odd jobs that do not lead to anything

that is of great value. The question which comes to us now is, how we can make the employers see that it is to their advantage to give a certain portion of the time of the boys and girls to the schools.

We have, at this time, under contemplation—I say contemplation, because we have not yet decided—a plan, by which there may be placed in some of the larger institutions a school with a teacher under the authority of the school district; for instance, at May's or Bailey's, where a large number of these young people are employed; and the question is if we may establish in those places schools which will not only teach the common branches, but possibly train the young people along the lines they are employed in, so that possibly five days of their time will be of greater value to the employer than the six days without such training.

I wish to say this in closing, that a "career ambition" is a splendid expression for my thought. This thought I have had for some years, that every course in school should go definitely somewhere, and that every pupil, in entering the high school especially, should know where he is going. In our technical schools we are becoming clearer and clearer as to where we are going; we are going into the trades or into engineering. Pretty largely in the high school of commerce, the boy or girl knows where he or she is going; they are going some place into business. The pupil there has some definite idea. In passing through these schools, I am impressed with the idea that the pupils have a notion of some kind of work they are going to do. In the academic high schools the pupils are not always quite so clear. Of course, we have the classical course that leads to the professions; and the students in the colleges and the universities know where they are going. But we have another class that we are not quite sure of. A serious question has arisen in the minds of some of us. Girls are usually better students than boys, but many do not like higher mathematics; some of them have no capacity for higher mathematics. We find girls who give up their music, for if they carry the four major subjects and their music, they do so at the hazard of their health. Now, the thought has come to us that if we could have a course in music that would make a major study, instead of mathematics, we would so train the girl in music that at the end of her four years' course she would not only have the culture, but the efficiency. The same with art. Why should not the pupils so study art that when they have finished they will have efficiency which will enable them to earn a living? I am inclined to think the aim for efficiency will bring a finer culture than that which comes from studying art for culture's sake alone.

MISS GRACE E. MAKEPEACE:—

I did not know that I was to have the very great pleasure of telling you that the continuation school was a success last year from the viewpoint of the teacher; that we feel it existed in spite of itself, in spite of everything. We had, as most of you know, very little support from anybody, anywhere. The

men at the head of our schools supported us, and of the employers that were represented by the employes in Mill Continuation school not one did we find who lifted his voice in protest. This condition did not obtain throughout the city. We found that the attendance in Continuation school was steady. That speaks much. The attendance was more regular than in the day school. If boys have a little spare time, they may use it for further physical development in the old swimming hole, yet we found these boys did not accept that opportunity. They came to school. Our boys and girls of today lack a definite idea of what they want to do. They are distracted by the multiplicity of advertisements. If one line of work requires less resistance than another, that is the line of work they enter; but after entering it and finding themselves illy equipped, they are easily turned aside. This accounts, in large measure, for America's industrial outcasts.

A boy came to me tonight to find out what might be done. He had left school before he was fourteen, leaving him about three months short of completion of his education in the grammar school. His grade at school was low, and rather than face failure, he went to work. This boy, a great, big, husky fellow, came to me in *distress*. He may have a better position if he can show an eighth grade certificate. He is attending Continuation school faithfully. What *test* shall such pupils be given? This boy will *not* be a failure in the work-a-day world.

You will no doubt agree that a boy is happy when he works. Give a boy something to do with his hands, where he can see something accomplished after he has worked a while. A boy fourteen years of age, who can knock down a wall, throw up another opposite, put in a window here and a door there, is brought down into the manual training class to glue a few pieces of wood together. (Applause and laughter.) I am glad you see the point. Yet in the work we did last year good was accomplished. On the first day, there were forty-eight bright boys and girls before me; I knew nothing to do other than what my experience had taught me. First, I found out what their heart interest was. Later, we formed a class of saleswomen, let the boys look on, and finally they agreed to be purchasers. We directed the different customers to enter—the grouty one, the one who didn't know whether he wanted anything or not, the one who visited with his friend. This taught concentration, even if in but small measure. We had a dramatic performance and in that way found out that the boys were interested in some line of work. We asked them about conditions in their shops. We had boys from the nut and bolt shops and we found nearly every one of them had the wrong idea of what an employer represented. You gentlemen would not have known yourselves from the boys' viewpoint, because the boys thought everything that was done in a shop by the manager was planned for their detriment. We began teaching the pupils where the materials came from; what the manufactured article represented; where it was to go; what it was to effect, and when they had this information they were surprised to know that it was a practical every-day problem; that it represented a part of their own life, and they came to realize at

the end of the 32 weeks that their employer was a very different individual; that the good of the company was *their* good. Working without a curriculum, I took the initiative and divided the period of six hours into three groups of two hours each. Two of those hours were devoted to civics and general deportment (attitude in a home, at the table, in a room with guests, the little courtesies of the boys to the girls and the girls to the boys, etc.). We went into the beautiful auditorium with waxed floor. The girls danced. The boys, after watching, were glad to take part, and so many of them learned to throw off a little of their awkwardness.

We talked about cleanliness, keeping the home tidy, took up color schemes and taught the boys something about stenciling, the use of paints, that the softer colors are effective for the home, and urged them to take the stencils they made in school to their homes. Having only ordinary rulers and paper, nothing but plans were drawn. It was not until late in the term that we made wood match-safes. One of the boys ventured to make a chicken coop during the summer from a plan worked out at school. He informed me the other day that he had seven chickens and had sold two dozen eggs at thirty-seven cents a dozen. Mill continuation school was a real live institution. We did everything we could for the benefit of the boys and girls. Especially did we feel the need of knowing *what* positions were open to these minors. There are many little factories, and if the big concerns hold out bait, in form of a local school, without loss of pay, it would seem discrimination against homes and many worthy firms as well as placing minors under personal obligation to their employers. The most serious objection is the seeming coercion of minors. The public schools of any country are its foundation stones; the only bulwark of free government. We must equip children not only with the English language, but with standards of workmanship and knowledge of American institutions. Our girls are *not* being prepared for the *HOME*. May we not have a school that will teach every girl what she should know about the home? Our girls must not be commercialized. The girls and boys should have an opportunity to know what work is needed in the world. They should be guided in their choice that they may make themselves happy in their life work. (Applause.)

MR. H. C. BAYLISS:—

You perhaps know that the problem of vocational guidance has been discussed a great deal of late, and that there are at the present time as many different ways of attacking the problem as there are cities attempting to do something.

Cincinnati is going at vocational guidance work in a different way than Boston, and Buffalo in yet another way. When it came time to solve the problem here in Cleveland, the Chamber of Commerce turned over to the Young Men's Christian Association the details of operation. It seemed obvious to us that the best way to proceed would be to find out how other cities were working. We knew that each city had its expert who could come

to us to explain the local process and answer any questions we might ask them. We think that in this way we may be able to decide on a method of operation for this city, which will be satisfactory and successful without loss of time or money.

We have organized by invitation a general committee on vocational guidance and this general committee has invited the experts to come here and address, at stated intervals, an institute made up of representative citizens from every phase of educational, social and industrial work. We wish to make this institute as comprehensive a group as possible.

We would like to have your Society select a member, who could be on this general committee, and also detail two or three more members to take part in the institute and listen to the experts and help us by their experience and discussion, to arrive at the best plan for our city here. We will appreciate it, Mr. President, if you will consider this official and at your earliest convenience appoint or choose your representatives for the general committee and the institute.

MR. T. G. PROTHEROE:—

For the past ten years the Young Men's Christian Association has served the business men of the city through its Employment Department.

As many as 500 men a month are interviewed personally regarding employment, and over a hundred of them on the average find desirable positions through the Department.

We, who do the interviewing daily, are mightily impressed with the great need of some organized system of vocational guidance, sufficiently practical to actually help a man find the work for which he is best fitted and in which he can make the most of his life. By actual count, we know that as high as 65 per cent of the men who come to us for employment do not know what kind of work they want to do, and they are a bright, capable lot of men, who come to us for service, at that.

There is great need for some centralized bureau, where men can get intelligent information about opportunities in the various occupations, and sympathetic counsel as to their fitness and adaptability to the various vocations.

A great deal of our time, too, is spent not in "matching up" men and positions, but in creating in the young man the right attitude toward his position and toward his employer. Considerable might be said about the employer and his attitude toward his men; and I hope this Society will have a genuine heart interest in the work of the general committee on vocational guidance for Cleveland.

MR. WILLARD BEAMAN:—

There is a new movement on foot in our city, of which I do not think many of you are aware. It is an organization of master workmen of the building trades; in particular, its purpose is to provide for themselves and for other trades skilled workmen by a course of education. The president of the organization is here tonight, and I am serving on this committee. He has

asked me to explain to you briefly what their purposes are, and what they hope to accomplish.

They hope to establish a school through the munificence of someone, so that they will take a boy—or a girl, if there be something in her line which she wishes to study—they will take that pupil when he or she leaves the grades, and instead of going into our cultural high schools, or our technical high schools, the pupil would go into this school for a few years, and be taught the science needed for some particular trade. There would be enough English and history taught to make this boy, if it be a boy, a good American citizen. He would be taught the mathematics; the chemistry, if you please, of his particular trade, so that when he graduated from this polytechnical school, as they designate it, he would be worth his room in whatever establishment he entered. It will, in a way, take the place of the apprentice system, but it is to make that boy of value enough so that the master workman can afford to have his services. They move in this direction because of the dearth of good material, and the difficulties of the apprentice system. These men feel this lack in our city and in this development of our civilization, which they did not feel in their own homes abroad, and they are endeavoring to meet this demand of our civilization in our time in that way. Now what we will accomplish, who can tell? Certainly, the purpose is worthy their earnest effort. They are master workmen in these trades. This is needed.

Over a year ago, there was appointed by the President of the Cleveland Engineering Society a committee on technical education. I happened to be the chairman of that committee. I pointed out the task and the committee did the work last year. We embodied in a report last month this study of ours. We took it upon ourselves to look into the question of technical education of all kinds and classes in the city, and report upon it, and here it is, printed for your benefit.

Now, the next thing is, what can we do? The primary purpose of our President, who appointed this committee, was to help the boys. We have a great many young men going into technical work; engineers, architects, etc. There are enough of them; we do not wish to proselyte. Although there is demand for all of those graduated from the technical schools, yet it is not the purpose to induce more young men to take this technical training. Many a boy used to be *sent* to college; some of them *went* to college, which is much more desirable. Often a father comes to us and says: "What shall I do with John? He thinks he wants to go to college. What had we better have him study?" We always ask them, "What does John say?" The answer frequently is, "I do not know, I have not talked to John about it." These fathers, of course, are not technical men.

We can aid these boys in first helping them to make up their minds whether or not they really do wish to take technical training; show them, and give them examples, so they will have a clearer understanding of what they want to be. We have been doing this the past winter, placing ourselves where these young men could get at us; but we do feel, as engineers, architects and

technical men, that our great duty to the city is, after all, more than in any other direction, toward these boys. I do not know whither it will lead us. I do not know what we will succeed in doing; if I did, it would not be worth doing. I expect, with Prof. Barker, that long before we get through we will know a great deal more than we do today. We had, however, an idea of the religion of service, we wanted to help the boys, and it may be the girls, too, of Cleveland, in the lines of work which we are following for our livelihood and for which we stand. That is, gentlemen, why we have this program tonight and why we invited these friends here. What is being done in Cleveland now, you see. There are several of us working in different ways towards the same purpose and it is new to us. When there are no more problems on earth I shall be ready to be translated. A grand old fellow up in the northwest said to me: "I am not ready to die yet, because there are so many interesting things. I want to see how they come out." This is the most wonderful country, the most wonderful age of the world's history. I never imagined until recently that the times could be so interesting as they are right now. We can't see a year, a month ahead of us and hardly in any direction.

MR. H. C. BAYLISS:—

I did not mention our apprentice school, because it has little connection with vocational guidance. We have one hundred and thirty-seven boys in this school. They are not boys who are under the law for continuation schools, but boys who are old enough to be without the law and are apprentices from different manufactories of the city. The ages range from fourteen to forty years. If a man sixty-five years of age would ask to come in, he would not be turned away. Our method of operation is to give the men related material which will make them more efficient in the shop.

We do not have a machine in the plant, we have only drawing boards, tables and blue prints. We have to make up our own lessons, because there is nothing published in the country worth while. It is a co-operative school; the employers paying the wages for the boy while he is in school.

I wish to say in regard to the discussion led by Professor Barker that all this seeming chaos in industrial education is going to result in this country finding the best way of giving industrial education, with the result that in a few years we will have schools so far ahead of the German continuation schools that they will not be able to see us for dust.

We hope some day that our school will be taken over by the public school board. We are not competing with their schools in any way, but we are simply pioneering, and when they are ready to take up our work, we will turn it over cheerfully and turn our attention to other tasks which need to be done.

APPRENTICESHIP SYSTEMS AND CO-OPERATIVE SCHOOLS IN RELATION TO TECHNICAL EDUCATION

- American Brass Founders' Association**, 1910—The production of foundrymen, by J. J. Porter. Explains the methods of foundry instruction in the co-operative engineering course of the University of Cincinnati.
- American Machinist**, 1910—Co-operative industrial education, by E. F. Du Brul. Abstract of a supplementary report of the committee on industrial education to National Association of Manufacturers.
- Mar. 24, 1910—Remarks on the above report, by W. T. Magruder.
- Nov. 24, 1910—Industrial schools and apprenticeship, by D. S. Kimball. Discusses industrial education and the training needed.
- Jan. 18, 1912—Training mechanics and engineers, by C. E. Downton. Describes the system of the Westinghouse Co.
- June 20, 1912—The status of co-operative schools, by C. H. Winslow. Favors the co-operative plan and gives descriptive analysis of the work at various schools.
- Engineering Magazine**, Dec., 1911—The educational bureau in industrial establishments, by W. H. Radcliffe. Considers its practical value as an adjunct to a large manufacturing or operating company.
- Foundry**, Oct., 1911—Practical course for apprentices. Gives details of a new system of instruction in foundry work, patternmaking or machine shop practice.
- Iron Age**, Dec. 8-15, 1910—The industrial training of boys, by J. J. Flather. Read before the National Founders' Association. Discusses the education and the development of the apprentice.
- Railway Age Gazette**, May 5, 1911—Instruction of workmen and apprentices, by H. S. Rauch. First prize paper. General discussion with suggestions.
- May 5, 1911—Improving and making mechanics, by I. H. Linn. Second prize paper. Discusses the education and training of apprentices and methods of increasing the efficiency of old employees.
- May 5, 1911—Instruction of workmen and apprentices, by J. W. L. Hale. Suggestions for practical education of employees to fit them for present industrial conditions.
- June 2, 1911—The Y. M. C. A. plan of instruction for apprentices and shop employees, by F. M. M. Richardson. An account of the work of apprenticeship schools under the Association plan.
- Machinery**, N. Y., March, 1912—The Cincinnati method of industrial education; a friendly criticism, by J. A. Pratt. Discusses points favorable and unfavorable to this plan.
- Society for the Promotion of Engineering Education**, 1910—Co-operative engineering education, by Herman Schneider. Explains the system of the University of Cincinnati.
- Wright, C. D.**—The apprenticeship system in its relation to industrial education. 1908 (U. S. Bureau of Education, Bulletin 1908: No. 6).

Society Notes

MINUTES OF MEETINGS

Sept. 10, 1912.—President Himes called to order the regular September meeting at 7:50 p. m., and on his suggestion to open the first meeting of the season by singing "America", Mr. Protheroe led in this fittingly patriotic opening.

The Secretary then read the minutes of the meetings of May 14, 16, 27 and June 11, which stood approved as read. President Himes called attention to the changes in the new constitution, especially those referring to the election of new members.

The speaker of the evening, Mr. V. G. Marani, was then introduced, who spoke on Building Codes with special reference to the Cleveland Building Code, following which there was a general discussion, participated in by Messrs. V. D. Allen, S. W. Emerson, A. F. Blaser, W. O. Henderer, G. F. Hammond and Myron B. Vorce, after which Mr. V. G. Marani made his closing remarks.

Adjourned.

DAVID GAHR, *Secretary*.

Sept. 24, 1912.—Special meeting called to order by President Himes, at 7:50 p. m. in the Library of the Chamber of Commerce building. Present about 100 members and guests.

The President introduced Mr. Willard Beahan, chairman of the Educational Committee, to preside at the meeting, and the speaker of the evening, Prof. James F. Barker, Principal of East Technical High School, was introduced by Mr. Beahan. "Apprenticeship Systems and Part Time Co-Operative Schools in the United States" was the subject of the paper, following the presentation of which Messrs. J. R. Luthe, F. H. Vose, A. J. Himes, J. M. H. Frederick, Miss Grace E. Makepeace, H. C. Bayliss and T. G. Protheroe took part in the general discussion.

Meeting adjourned by singing "America".

G. S. BLACK, *Acting Secretary*.

Oct. 8th, 1912.—Regular meeting called to order by President Himes at 7:50 p. m. Present 103 members and guests.

The minutes of the meetings of Sept. 10 and 24, 1912, were read and approved.

President Himes announced the election by the Board, at today's meeting, of the following men to the grades of membership indicated:

Active Members—AUGUSTE BIENFAIT, EDWARD C. HOFFMAN, CLARENCE S. IZANT, JENS O. JENSEN, JOHN C. GILLETTE, GEO. H. HULETT, ALFRED E. JAMISON, WARREN C. KALB, WILLIAM H. TURNBULL.

Associate Members—JOHN R. BISSET, WILLIAM J. CRAIGEN.

Junior Member—HARRY S. NELSON.

Announcement of applications received by the Board at today's meeting was made as follows:

Active Members—ERNEST JULIUS AFFELDT, JAMES M. FRASER, EDWARD A. KILROY, ERNEST JAMES NEWTON, HENRY M. WILSON.

Associate Member—JOEL GAHUSE.

Junior Members—HAROLD E. BARROW, HARRY EUGENE POPP.

A written report from the Building Code Committee, recommending that the Society lend its aid in securing a revision of the Building Code of Cleveland, was approved and adopted.

A report from the Public Safety Committee concerning "Fire Prevention Day" was read.

Brief remarks by Mr. E. K. Hiles, Secretary of the Engineers' Society of Western Pennsylvania, the keynote of which was co-operation, touching upon the proposed joint excursion of his Society and ours were happily replied to by Mr. Himes.

President Himes then introduced William H. Alexander, official in charge of the Cleveland Section of the U. S. Weather Bureau, who delivered an excellent lecture on "The U. S. Weather Bureau and Its Work".

Adjourned.

DAVID GAEHR, *Secretary.*

Oct. 15, 1912.—Informal meeting in the rooms at 7:40 P. M. Mr. B. A. Stowe presiding. Present about 40 members and guests.

Dr. A. W. Smith, Director of Chemical Laboratory, Case School of Applied Science, presented a paper on "Boiler Waters and Methods of Softening", which was followed by a lively discussion.

Adjourned.

Oct. 22, 1912.—Special meeting called to order by President Himes at 8:15 P. M. Present about 125 members and guests.

There being no business to come before this meeting, President Himes introduced Mr. G. F. Ahlbrandt, of the American Rolling Mill Co., who presented an illustrated paper on "Ingot Iron Versus Steel".

A lively discussion followed the presentation of Mr. Ahlbrandt's paper.

Adjourned.

G. S. BLACK, *Acting Secretary.*

Memoirs

GUSTAVUS A. HYDE,

Retired Member, The Cleveland Engineering Society,

DIED Nov. 26, 1912



RESOLUTION

RESOLVED, That in the death of our late fellow member, Gustavus A. Hyde, on the 26th day of November, 1912, this Society and the profession at large has suffered a serious loss, a very capable man;

That we extend to his family our sincere sympathy;

That a copy of the Memoir, as printed in the Transactions, be forwarded to his family, and that this Resolution be spread on the records of this Society.

Gustavus A. Hyde, the second son of Henry Hovey and Keziah Rice Hyde, was born Jan. 15, 1826, at Framingham, Mass., and died Nov. 26, 1912, at Cleveland, O.

He received a partial academic education, after the age of twelve making his own way in life.

In February, 1843, he became one of the first volunteer weather observers under Prof. James P. Espy, a scientist and meteorologist, of Washington, D. C., and continued a weather observer until his death, sending copies of his observations to some government department continuously from May 1, 1855, to Jan. 1, 1906, and frequently furnishing information about the weather to the local daily papers. Since 1906 he took observations for his own information only.

He gave lectures on Storms of America, explaining the theory of storms and their movements, before the Civil Engineers' Club of Cleveland, Electric Club, Historical Society, Normal School, East Cleveland High School, Plymouth Church Men's Club and Willson Avenue Baptist Church Men's Club.

He published a review of his forty years' record, which he gave to all the weather observers in Ohio, colleges and schools, Chamber of Commerce, and many other interested persons, and also published a fifty-year review and distributed a small number. This was done all gratuitous.

He was a civil engineer and surveyor by profession. He was engaged on the Boston waterworks, surveying the land used for the waterworks and serving in the engineering department, constructing an aqueduct from Lake Cochituate to Brookline, near Boston, during the years 1846 to 1849.

He went "out west", as it was denominated in earlier days,

arriving at Cleveland on April 20, 1850, via Buffalo, on the steamer Tecumseh.

He was assistant engineer on the Cleveland and Pittsburgh railroad, then being built from Cleveland, during the remainder of 1850, having charge of the building of a pile breakwater along the Lake Shore between Water and Erie streets.

During the years 1851-4 he ran the location line, and as resident engineer, had charge of the construction of that portion of the southern division of the Lake Shore & Michigan Southern railroad, extending from Toledo to Bellevue—45 miles.

He was the second city civil engineer of Cleveland, during the years 1855-8.

He served as engineer of the Cleveland Gas Light & Coke Co., from Feb. 1, 1859, to March 1, 1907, a period of more than forty years, making plans and having charge of the construction of most of the buildings and machinery at both of their gas works. He also made plans and had supervising charge of the erection of several other gas works in Ohio, Michigan and Pennsylvania.

He retired from active business life early in 1907 on a life annuity provided by the Cleveland Gas Light & Coke Co.

He married Mrs. Elizabeth R. Williams at Fremont, O., Nov. 6, 1852. Mrs. Hyde died Sept. 30, 1903, at Cleveland. They had five children, three of whom survive.

Mr. Hyde possessed a most genial and affable disposition, kindly by nature, of strong religious tendencies, and enthusiastic in his meteorological studies.

Mr. Hyde was a charter member of the Cleveland Engineering Society.

JOSHUA DAVIS VARNEY,

Retired Member, The Cleveland Engineering Society

DIED OCT. 21, 1912

RESOLUTION

RESOLVED, That in the death of our late fellow member, Joshua Davis Varney, on the 21st day of October, 1912, this Society has suffered a loss and our profession a very proficient man;

That we extend to his family our sincere condolence;

That a copy of the Memoir, as printed in the Transactions, be forwarded to his family, and that this Resolution be incorporated in the minutes of this meeting of our Society.



Joshua D. Varney was born in Brant, Erie county, New York, Aug. 4, 1833. He came to Cleveland in 1872 and practiced

surveying until his retirement the past summer, a period of forty years.

As a member of the Society for many years, he was frequently solicited to prepare a paper embodying reminiscences of his interesting and useful career. He finally consented, and the paper was read at a special meeting, held in the Auditorium of the Chamber of Commerce. The meeting was largely attended and was turned into a personal tribute to a most worthy and capable man. Many speakers participated. The paper and addresses appear in the March, 1911, issue of *THE JOURNAL*. He was then in fine physical condition despite his years.

About a year ago his wife died, after a long illness, and soon thereafter his own health commenced to weaken. His daughter, Mrs. Luella Serrao, an only child, came to his side and thinking he might be benefited and live to enjoy the scenes, took him to her Italian home in Rome, where he died Oct. 21, 1912.

Mr. Varney was a man of fine and engaging personality. One that was closely associated with him for a number of years describes him as one of the finest characters he ever knew.

Mr. Varney was elected to membership in the Cleveland Engineering Society Aug. 14, 1883, became a retired member in 1904, and retained membership until his death.

OUTING OF THE ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA AND THE CLEVELAND ENGINEERING SOCIETY

A delegation of about eighty from the Engineers' Society of Western Pennsylvania came to Cleveland on Nov. 2, for a joint inspection of several Cleveland manufacturing plants with the Cleveland Engineering Society.

After the arrival of the special train from Pittsburgh, the remainder of the forenoon was spent in observing the manufacture of paint at the Sherwin-Williams plant. Pigments, vehicles, solvents and driers in great quantities were traced through interesting processes of preparation and combination into cans, ready for the painter's brush.

An acquaintance tag was on the lapel of each man's coat. The local engineers' tags contained the names only, but the visitors' tags showed the names and occupations of the wearers. One disputative visitor, before he arrived in Cleveland, printed boldly on the line for his occupation, *Pugilist*. After he caught sight of the size of the Cleveland delegation, he quickly scratched out *Pugilist* and printed over it *Mechanical Engineer*.

Buffet lunch in the library of the Chamber of Commerce was a pleasant occasion for acquaintance and fraternal spirit. After short talks by President Handy, of the Engineers' Society of Western Pennsylvania, Dr. Brashear and President Himes, the Ionic quartet sang several selections.

In the afternoon two inspection trips were arranged, one east and one west on special trains from the Union Station. The

party taking the east trip visited the plants of the White Company and of the Cleveland Electric Illuminating Company, while the party going west inspected the Winton Motor Car Company's plant and the Pennsylvania ore docks.

Concerning the west trip, *The Cleveland Plain Dealer* said in part:

Standing on the wind-swept deck of the steamer Quincy Shaw yesterday afternoon, as the giant arms of the Hulett unloader dipped down into her hold to rise again with 17 tons of iron ore in the clam, was a short, sturdy figure, keen and active in spite of the gray hair which betrayed age.

Around this man, listening with respectful attention, were three or four-score Cleveland and Pittsburgh engineers.

It was G. H. Hulett himself, vice president of the Wellman-Seaver-Morgan Co., designer of the ore unloader which was being inspected, a man known the country over for his inventions and improvements to machinery.

In spite of the cold wind, the group listened amazed as the designer explained that every time a bucket came out of the hold of the Quincy Shaw, 17 tons of ore came with it, that a 10,000-ton steamer had been unloaded in five and one-half hours, and that only one minute was required for the bucket to complete a cycle.

The bucket, explained Mr. Hulett, discharges into a 65-ton hopper, which in turn discharges into a 50-ton larry car, equipped with scales. The larry car unloads directly into cars beneath or on an ore pile. All this machinery is electrically controlled, two men being necessary to operate the entire machinery of one unloader.

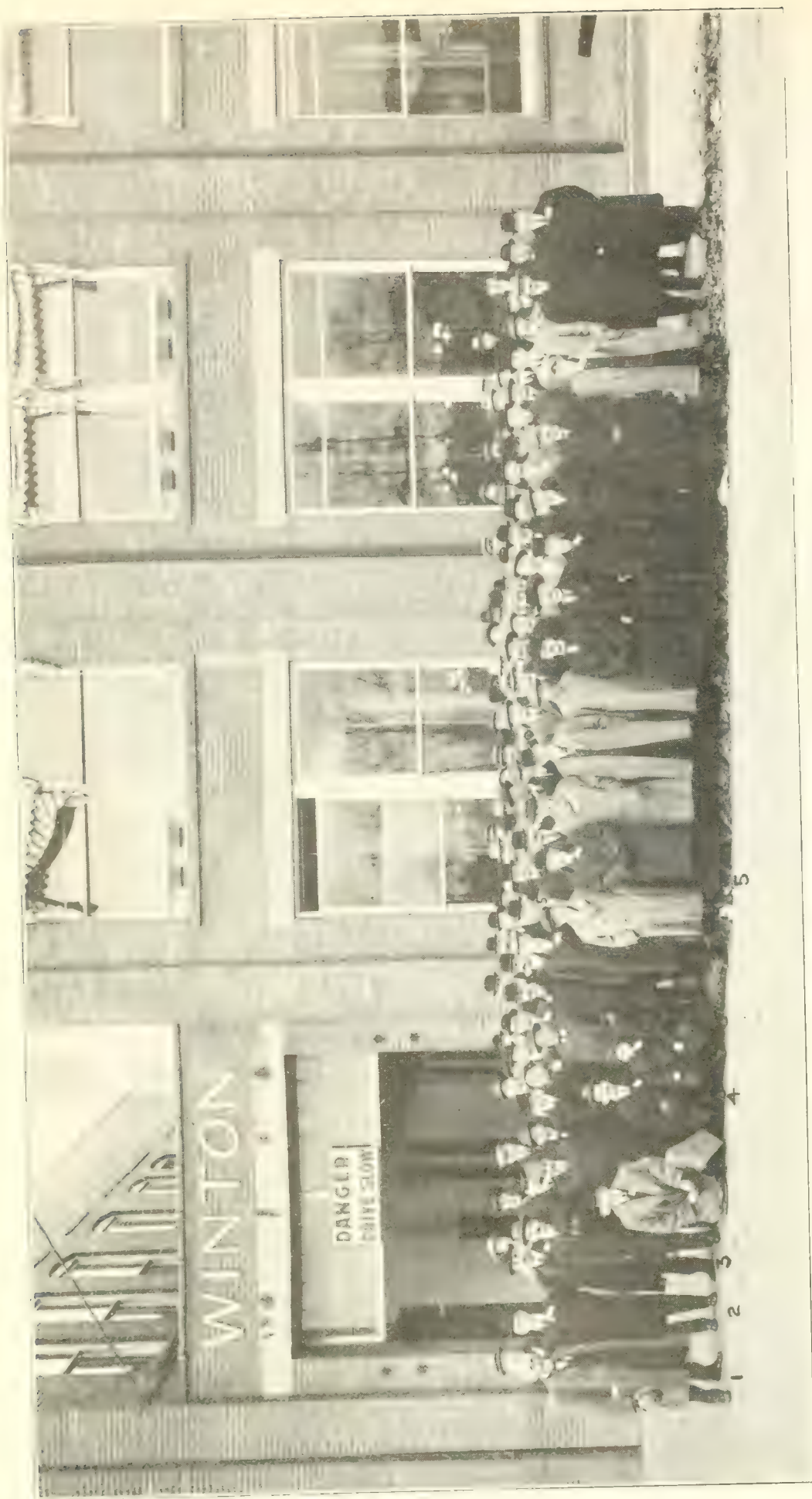
As the group broke up, a small, elderly man stopped to speak to Hulett.

"My name's Brashear; I'm from Pittsburgh," he said. He spoke simply and quietly, his manner betraying no indication of the deference displayed toward him by the men from Pittsburgh.

"Pittsburgh's first citizen" is the title bestowed on Dr. John Brashear by his fellow citizens. Dr. Brashear is known as a lens-maker, whose lenses are in the largest telescopes in the world.

For over 30 years, Brashear has been an intimate friend of Ambrose Swasey, of Cleveland, the latter having made the machinery and telescopes for which Dr. Brashear manufactured the lenses.

Any account of the outing would be incomplete without mentioning the spirit of hospitality displayed at all the plants visited. Careful planning of their officers for the convenience



VISITING PARTY—WINTON MOTOR CAR CO.
 No. 1, Dr. John Brashear; No. 2, Jas. O. Hardy; No. 3, A. R. Raymer; No. 4, E. K. Hines; No. 5, G. H. Hulet,
 INVENTOR HUETT UNLOADER

and instruction of the visitors, contributed in a great measure to the success of the program.

In the evening the parties united at the Hotel Statler for dinner before the train left for Pittsburgh.

INFORMAL MEETING

On the evening of November 19 at an informal meeting, Mr. W. O. Henderer, president of the Osborn Engineering Company and vice president of the Cleveland Engineering Society, presented a paper on "The Testing and Inspection of Structural Materials."

INSPECTION TRIP THROUGH THE PLANTS OF THE GLIDDEN VARNISH COMPANY AND THE NATIONAL CARBON COMPANY

Those who took both the trip through the Sherwin-Williams plant, on Nov. 2, and the Glidden Varnish plant, on Dec. 3, are very fortunate. A study of paint-making is properly supplemented by a study of the varnish industry.

At the Glidden plant varnish is mixed by circulating compressed air through it. It is improved by a special filtering process in a much shorter period and to the same degree as was formerly done by a long aging process.

In the National Carbon Company one realizes the great number of electric appliances of which carbon products are a part. Of especial interest was the research department, where various kinds of lighting devices using carbon as an illuminant were being tested.

A little later, the dry battery department is reached, where 50,000 cells may be made in a single day. Then that department is entered where carbon products are in the course of manufacture from the raw ingredients of coke flour and tar to the delicate parts of a telephone and the great poles of an electric furnace.

SMOKE ABATEMENT COMMITTEE PROGRESS REPORT

As indicated in a preliminary report, this committee is making an attempt to collect and compile reliable data which will be of use to Cleveland furnace owners and designers. At present a number of power plants, known to be practically free from smoke, are being investigated and the data collected will be published in *THE JOURNAL*.

It should be borne in mind by those reading this report that it constitutes only a portion of the work undertaken by this committee. The results given in this and future reports hold for each particular plant and for the conditions under which that plant operates. In making application of this material, due con-

sideration should be given to analysis made of all details entering into the design and operation of such equipment.

PLANT No. 1.

The boiler plant consists of sixteen, Type F-17, Stirling boilers, each having an effective heating surface of 2,932 square

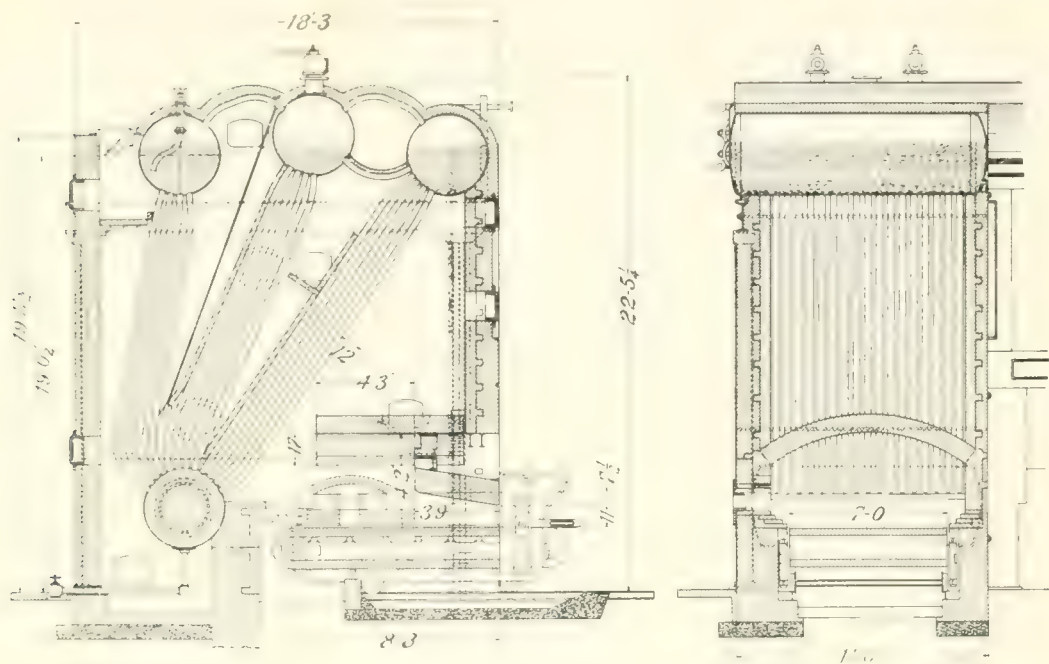


FIG. 1

feet. Each boiler is fired by one chain grate stoker with an effective grate area of 60.5 square feet. The grate links are made from a special design, which gives approximately 34 per cent air space. Draft is furnished by two brick stacks, having an internal diameter of 9 feet and a height of 200 feet. Each stack serves

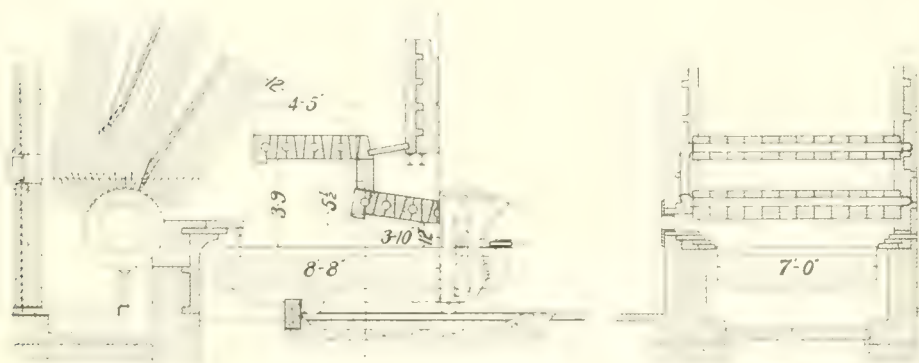


FIG. 2

eight boilers. The normal draft just below the damper is 0.5 inch and in the furnace about 0.18 inch of water.

Engineers representing the company and the stoker manufacturer designed these furnaces to prevent smoke. This design has not only been successful in accomplishing this purpose, but has been a potent factor in maintaining a high furnace efficiency.

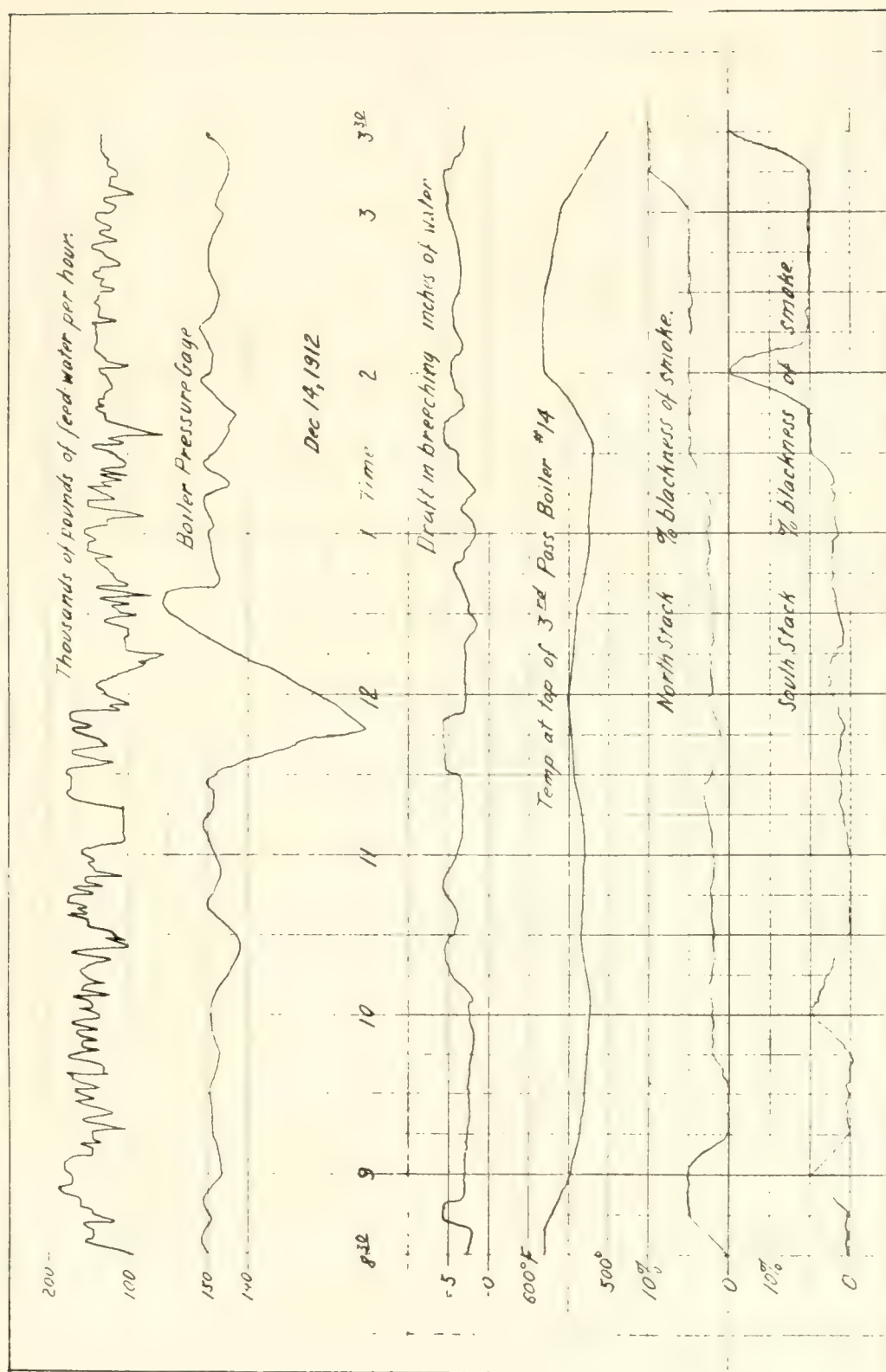


FIG. 3

As shown in Fig. 1, the original furnace design consisted of a flat ignition arch at the front of the furnace, followed by a spring arch, which forms a large combustion chamber. Twelve furnaces are built in this manner.

The modified construction shown in Fig. 2 consists of two flat arches. This change in the design was made by the company engineer in order to obtain the benefits of the decreased cost of maintenance, and the increased capacity and efficiency which result from the use of this type of arch. This modification produces no change on the plant so far as smoke is concerned.

On Dec. 6, 7, 13 and 14, the operating conditions at this plant were observed by E. L. Lannert, R. E. Kipka, E. A. Rosendale and R. A. Wilson, members of the senior class in mechanical engineering at Case School of Applied Science.

These men report that the operating conditions on the given days were as follows:

Observations were made as on a regular boiler test. The over all results are, however, only approximate, as several of the items were obtained from the company's recording instruments.

A graphic log sheet of some of the observations made on Dec. 14 is shown in Fig. 3.

As indicated by this log sheet, the smoke from either stack never ran over No. 1 by Ringelmann's smoke chart.

Coal used:—No. 8 Ohio, Bituminous Run of Mine, averaging about 12,200 B. T. U. per pound as fired.

On Dec. 14, the average per cent rating developed was 105 per cent; the maximum 115 per cent.

Other average figures obtained on Dec. 14 were: Average CO_2 at top of third pass, 10 per cent; average flue gas temperature, 540 degrees; average draft in furnace, 0.18 inch of water; average pounds of coal per square foot of grate area per hour, 21.6; average thickness of the fires, 4.75 inches; average speed of the grate travel, 3.4 inches per minute.

More detailed information concerning this plant may be obtained from the members of the committee.

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F. M. KINSLEY.

T. A. LAWES.

H. P. RODGERS.

F. H. VOSE.

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The New Era in Machine Tool Design

BY E. P. BULLARD, JR.

Mr. President and Gentlemen:—I appreciate the honor which you have conferred upon me by asking me to speak to you tonight on a subject which, while of interest to the machine tool builder, is not of especial interest, as a rule, to the average shop man. I will, however, endeavor to treat the subject in a general way, so that it may prove of interest to all.

I chose the title of this address because I believe that a new era has come in the mechanical world. We have been given a new word during recent years and a new profession has been created. We are told that our shops are inefficient; that our methods are out of date; that we make a great many false motions. Our railroads have been informed that they lose a million dollars a day by inefficient operation. It is stated that a railroad car is in use but two hours out of the twenty-four. This new knowledge is the result of careful analysis, and exact knowledge, so obtained, forms the foundation for the new era.

What do all these things mean? They mean that there is a great demand being placed on the mechanical world at large. All of our industries are being called upon to produce better goods at a lower price and to increase production. We must be more efficient in all our work, as engineers, as shop managers, if we are to succeed. We cannot hope to be paid for inefficiency. The world is going on; it is not standing still, and those of us who are going to uphold the names of our concerns and our individual reputations before the mechanical world, can do it only by keeping pace with the times.

You ask, what has this to do with machine tools? Stop and think. Can you think of a device, a mechanism of any description, which is not affected by the efficiency of machine tools? Everything we have, safety razors, even the capsules in which we take our medicine, are the product, indirectly, of machine tools. We have come to an age of exact knowledge. We no longer do things in a haphazard way. We have means for measuring accurately and of determining the strength and hardness of materials. A bolt made in the East will fit a nut made in the West. We have come to a state of exact knowledge where we must use that knowledge in the design of our product, so that we may profit by the experience of others, and so that we may have products which will be comparable with products turned out in this country and abroad. We know the strains and stresses of materials. We no longer buy our materials by guesswork. We do not place an order for so much steel and let the steel mill send us any kind of steel it has in stock. We specify the percentage of carbon and the chemical analyses of the steel, and we expect it to give certain physical results,—so many thousand

pounds tensile strength, a stated elastic limit, a certain percentage of elongation, etc. We have come to the age where we can specify definitely what we want and get it. Standardization has become the watchword. We can specify a certain number of thousandths gauge and get it. A gauge made in one section of the country will fit or check with a similar gauge made in another part of the country. We standardize our operations. We make time studies of operations and benefit thereby. We have gone by the age when it is argued that a time study is of no benefit. We know that we can definitely calculate the time of machining a certain piece. We know also that the time which is definitely calculated in that way may appear to be absolutely impossible of accomplishment. I remember the first automobile flywheel that we produced. Our estimators figured that we could machine one of these flywheels in nineteen minutes. The work came into the shop and the shop superintendent came to me and said: "That is a joke." "What is a joke?" I asked. He replied, "That nineteen minutes. It will take nearer forty-five minutes." However, we found that by following out the time study we obtained our planned result. We have a letter in our files today from the concern that purchased the machine saying that they have averaged a time of seventeen minutes per piece on 14,000 flywheels. I give you this as an illustration of the value of a time study. Without planning the sequence of operations and following the plan we could not have accomplished it. As it was, we averaged seventeen minutes each on 14,000 wheels, showing that many of those wheels must have been made in considerably less time.

We have our instruments of precision. Have any of you ever stopped to think what marvelous things they are? Marvelous in their exactitude—instruments with which we can measure almost anything you can think of, from the hardness of material to the exact size of a particular piece. I sometimes marvel because I know the difficulty of maintaining these standards.

We have a demand, a tremendous demand, an exacting demand, a demand from the masses, for better conditions of living, of travel; they want heat, light, comfort, all the thousands of luxuries which this age has given us, and which now become necessities. Now, how is this demand to be met? We think of it as extravagance, but is it? It is simply the masses living up to the age. There was extravagance in earlier periods than ours. Louis XVI, it is said, spread gold dust on his royal signature instead of blotting it. We have other ways of being extravagant. We want automobiles, we want telephones, we want the thousands of things today which were luxuries at one time, but are now considered as absolute necessities. The luxuries of today are the necessities of tomorrow.

The machine tool must meet this demand. The burden of this demand bears directly on the machine tool, which is the prime factor in the development of civilization. A fanciful thought, I will admit, but it is always the prime factor in meeting this demand; in producing the articles which the world wants. If we are to meet this demand we cannot do it by walking in

the footsteps of our fathers. They bought iron and bought steel. They did not specify what their iron was to be, nor did they specify the analysis of the steel. They used other materials, such as bronze, which was yellow, and as long as it was yellow it was good for a bearing. We cannot walk in their footsteps and win. We must utilize the knowledge which is available. We must use the instruments of science and we must profit by the experience of other industries. Other industries have advanced

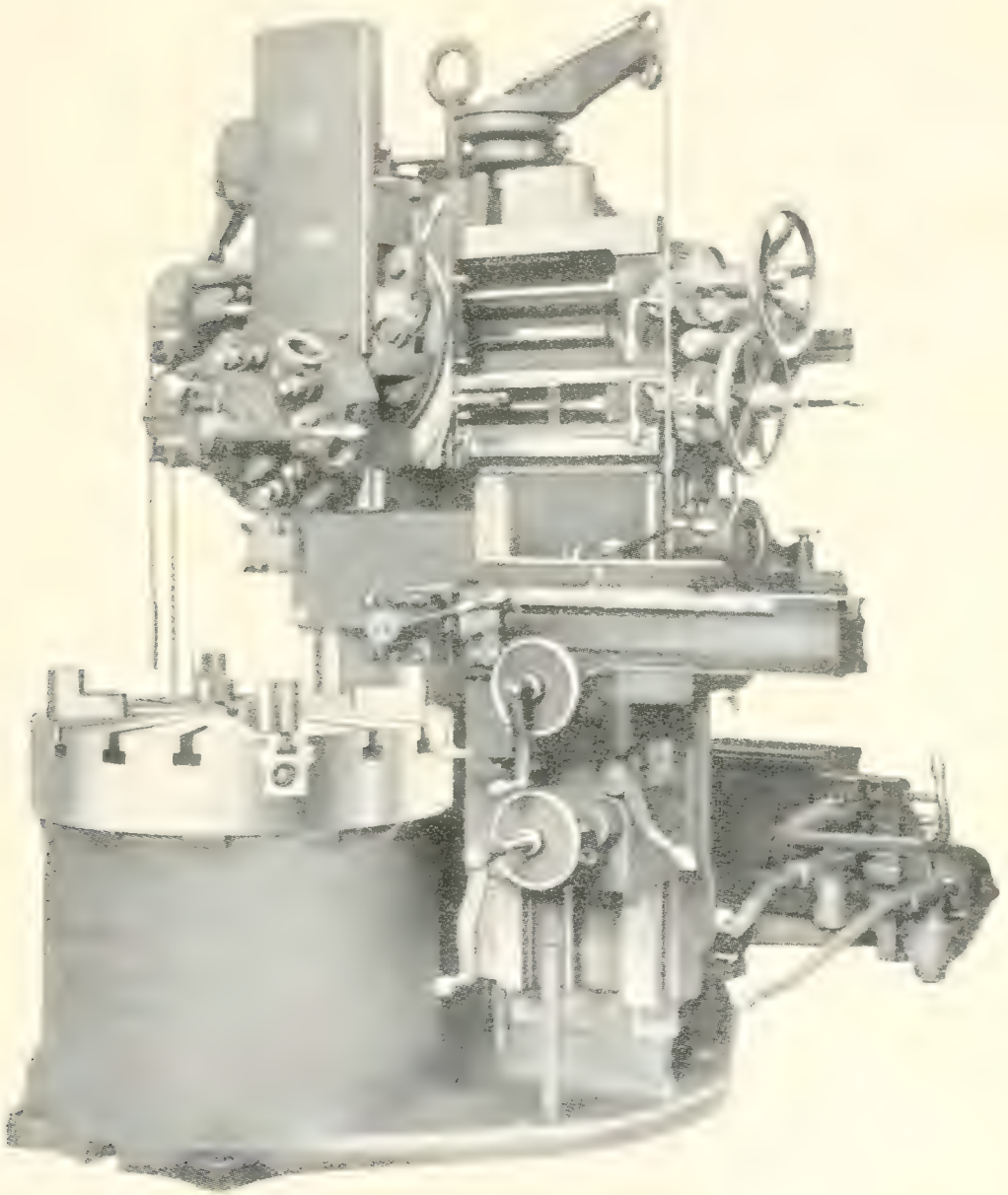


FIG. 1

amazingly. Take the automobile industry as an illustration. It started but a few years ago; very few, comparatively speaking. The early machines were crude; materials were not suitable for the service required of them. The demand arose for better materials, more suitable materials, and the materials have been supplied, until today a study of the materials that enter into a good automobile is a wonderful study, a comprehensive study. The manager of one of our automobile concerns told me there

were fifty-three distinct varieties of steel in his machine, each one selected as best for a certain service.

Granting that the machine tool is a prime factor in the advancement of our civilization, it seems right and proper that machine tool builders should exercise their energy to make their machines more productive, more useful, if they are to be a real help in the upbuilding of other industries.

How may this object be attained? The answer lies in the one word "Analysis"; analysis of the work to be done, the conditions to be met, and analysis of the means already at hand.

Have designers followed this method? What difference is there between many lathes of today and the lathes of ten years ago? That is the point, gentlemen. There is *not* the difference between the machine tools of today and the machine tools of ten years ago that there should be. They have not, in all cases, kept up with the times. Many machine tools are, today, identical in detail with the construction of ten years ago. But I tell you that anyone who continues to build a machine of that kind cannot hope, because of its inefficiency, to keep his trade. The machine tool of today must meet the conditions of today.

In analyzing the various elements of machine tools the question naturally arises, wherein can they be improved? There are many ways. First, let us consider the question of control. Control is the essence of machine tool design. It plays the largest part in the production of work. Control is everything. We see it in other products and never think anything about it. When we touch a typewriter key and the letter is impressed on the paper, we think little of that; but there is infinite exactitude in getting that impression. And so with the machine tool. It must not merely be started and stopped; it should be started precisely at the right time, under perfect control, and it should be stopped exactly as you want it and stay stopped until it is again started. The machine tool should do the work, and the operator should use his energy solely in directing it. He should not be called upon to spend his valuable time nor his mental energy in operating an oil can on sixty or a hundred different holes which are supposed to be oiled. He should not be called upon to shift dangerous belts or move heavy parts. There is absolutely no occasion today for an operator to be required to do those things, and any machine which compels the operator to use his physical energy to move heavy parts, to shift belts, or do any of those things which waste time and productive energy, is inefficient in design and construction.

What, then, are the essentials of machine tool design?

1st. The things that we can lay down and say we must have—Productibility. It seems reasonable that we should ask for productibility, the ability to produce. It is of prime importance, for it is what we buy the machine for, and if we cannot get productibility we have not spent our money wisely.

2nd. Durability. Is it unreasonable to suppose that, having

paid coin of the realm for a machine, we are not entitled to durability? Should not a machine stand up and do its work under present conditions, with inefficient men, may be? We are entitled to that. So, durability I place second. Productibility, of course, is qualified by durability. If it is not a durable machine its ability to produce ceases. So, it is reasonable to ask that a machine be durable, that it will remove the amount of material required in a given time and do it easily and comfortably, and have a sufficient factor of safety in the design of its parts to provide for a continuous performance of the work for which it was installed.

3rd. Adaptability. By adaptability I mean the ability of the machine to meet conditions. Let us assume that we have purchased a machine for a given purpose. The machine should

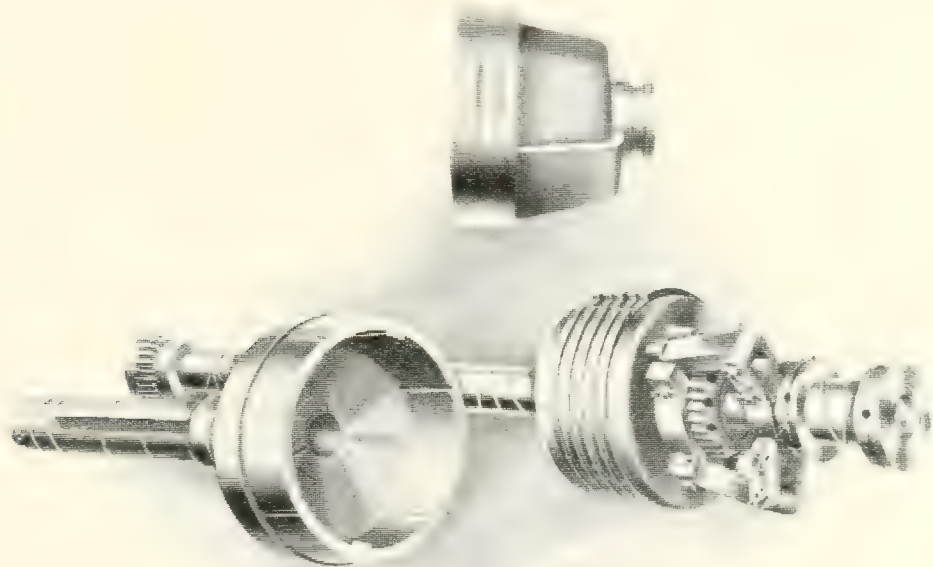


FIG. 2

meet these conditions. It is of little interest to us that it may be able to produce work for somebody else; that it may meet Jones' conditions. What we purchased it for was that it should meet our conditions.

We have, then, three essentials in machine tool design: Productibility, which means the ability to produce; durability, or the ability to stand up and do the work, and adaptability, or the ability to meet our conditions.

There are several factors which enter into the question of productibility, each of which is, in a way, related to the others. If, for any reason, the machine is not in service it is not producing and is, therefore, inefficient.

Continuous operation is an essential factor which is dependent not only on durability but on adaptability as well. If minor details of construction are constantly giving trouble it is not a

durable machine, and if long delays are frequently occasioned by the necessity of changing or providing complicated and expensive tool equipments the machine is not adaptable, and the expenditure therefor has not been wisely made.

I have already spoken of the starting and stopping, and wish to impress upon you the importance of that detail. I believe the starting and stopping of a machine is, possibly, the most important function of the operating mechanism. The machine should start just when the operator wants it to. It should not start a little ahead of time and take his hands off or his arms off, and it should not lag in starting. It ought to stop just as exactly as an automobile, a trolley car, or any other moving object. The starting and stopping of a machine are two very important factors in its operation. Shifting belts do not meet the new conditions; they are too slow. Efficient clutches are difficult to make. In fact, I think the weak point in about ninety per cent of the automobiles is in the clutch. The clutch does not work; it starts too quickly, or it drags. Some of you probably drive automobiles and you know that the clutch is a very important part of your machine. A clutch in a machine tool is equally important. It cannot be too good, and the brake merits equal consideration.

Let us consider the power operation of heavy parts. Did you ever stop to think what it means to take hold of a large planer or a lathe and move the heads or carriage any distance? It is a tremendous piece of work. A man who is not in training cannot do it, and a man who does it frequently during the day is spending a large part of his energy in useless work, wasting his physical as well as his mental abilities, because power can be applied to the operation of those parts just as easily as to driving the tool. Power operation of heavy parts, gentlemen, is here to stay. It may be inefficient on some machines, it may be inefficient on all, but the time will come when you cannot hire a man to run a machine in your shop unless the machine is equipped with mechanical means for operating the heavy parts. I refer to machines having heavy parts, of course. I do not expect to see the little light parts power controlled, but the time will come, just as sure as can be, when a man will refuse to run heavy machines not so equipped. Consequently, it is essential that we should produce machines that are equipped in that way. Incidentally it is just as essential that we should perfect the operation and motion of those parts so that they are under as absolute control as the control of starting and stopping, which I have already stated is very important.

In the matter of the setting of tools, I wonder if any of you gentlemen have ever done what I have done? I have gone around the country with a stop watch in my pocket, so that the operators could not see it, and have made time studies on my own account, recording the time which the average operator requires for the setting of tools. My calculations may not agree with your ideas on that subject, but I am convinced, and I think it can

be demonstrated in your own shops, that about one-third of the total time you pay for is spent in securing sizes. For instance, a machinist is turning a steel casting, and he does not want to spoil it. He has to reduce it to an exact size. He puts it on the machine and spends about fifteen minutes cutting it down a little. After that he tries the calipers on the turned surface and finds that it is about one-eighth of an inch too large. I notice it is usually about one-eighth of an inch. He then starts in and repeats that operation several times. One man out of a thousand can set a machine accurately enough to do this work without wasting time, and the other nine hundred and ninety-nine will do just as this one did. You can see it everywhere. Consequently your machine tool should, to be efficient, take that burden off the man and give him means of obtaining sizes quickly and accurately, and of duplicating sizes every time, so that the mental strain, due to his feeling of responsibility for the casting,

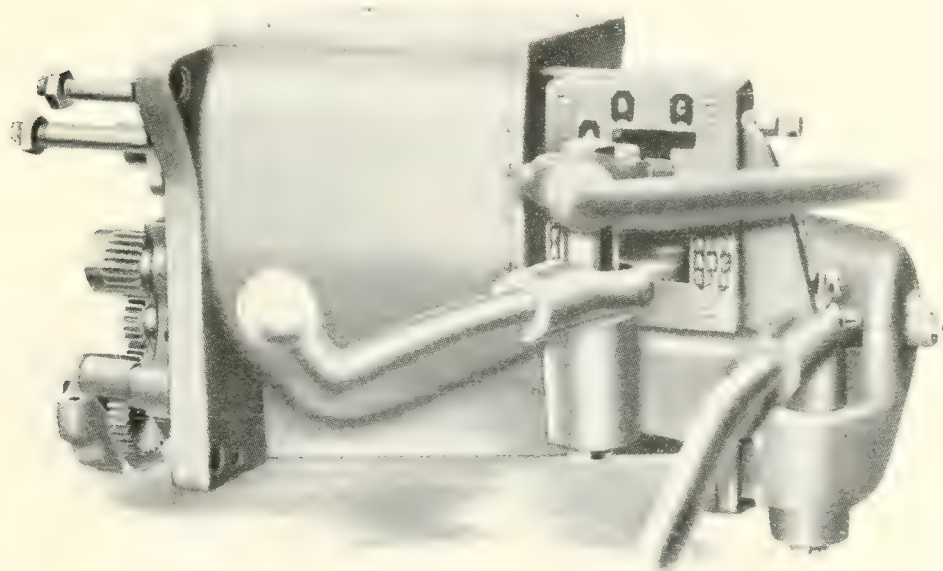


FIG. 3

is taken off his mind, and he feels free to set the tool in the shortest time and in the most effective manner.

Under productibility comes the question of power. How often do you see a machine that can be loaded up to all the tool steel will stand, and take cuts easily and comfortably and look as if it was going to continue to take them as long as necessary to machine the piece? What do you say? I suppose there are fifty compounds on the market for making belts pull, but let me tell you that a truly efficient machine tool does not need them, for the power will be there in the form of a big belt, a wide belt, and there will be plenty of strength of materials between the belt and the cut to take all that the belt will pull, and the belt should pull more than the cutting steel will stand. We know that it is possible because we do it.

I have seen a comparatively small machine turn off 1,785 pounds of cast iron chips in an hour. The casting was large

and the cuts deep, heavy and fast, in fact unnecessarily so, but the machine came through the durability test without difficulty and proved that the design was right.

Power in abundance, excess of power, is an essential part of a producing machine and it is in this respect that the average machine in the shop is lacking.

Now, as to the correct distribution of metal: Probably every man, when he buys a machine tool, first asks the question, how much does it weigh? Now stop a minute. What does that question amount to? If I, as a machine tool builder, wish to deceive you I can pour pig iron into the base of my machine and give you weight that costs little and is valueless to you. We can take little, lightly designed machines and fill them up in the bottom and give you weight, but you would not have productivity, because the weight would be in the wrong place.

You will find in the text books, which have been prepared during the past ten years, statements to the effect that machine steel may be turned at the rate of 25 feet per minute, cast iron at 30 feet. Now let me tell you something: I have seen a piece of machine steel, 40 carbon open hearth steel, turned at 425 feet a minute, just like a piece of wood, and turned easily and freely, and that was done because the machine that was doing it could do it easily; it did not vibrate and the cutting tool had an opportunity to work. The cutting tool is a delicate thing, when you think of it. It must have a keen edge to work properly. If it has a dull edge, which it gets very soon after vibration sets in, it ceases to be a cutting tool and becomes a *pushing* tool, and these ragged, torn chips you see around a shop represent inefficiency, lost power, poor tools and poor machines. The correct distribution of metal is an essential point. I have seen a boring machine take a cut $1\frac{1}{8}$ inch wide, $\frac{1}{32}$ inch deep, at 150 feet cutting speed a minute and produce a smooth cut. That was a finishing cut on a cylinder and it was satisfactory. Only the correct distribution of metal can give that result, and that tool could not be made to stand up if the metal in the machine were not there to properly support it and hold its cutting edge right to the work. The correct distribution of metal is one of the very important factors in machine tool design. I believe that machine tools as a rule are light in some of the very essential parts. I am speaking of the general run of machines which I produce and which others produce. I believe they are light in essential parts, and I believe that when we come to have a full understanding of where we should place metal and how we should place it and what kind of metal it should be, we will make a great advance.

There is another point we can make in the cutting of metals, which has to do with the production of work, that seems to me to have infinite possibilities, and that is the use of cutting lubricants. I had it brought very forcibly to my attention some time ago that there was a large saving to be made in power by the use of cutting lubricants. A machine was in operation in our plant on a steel casting. The foundry, for some reason best known to themselves, had left about three-quarters of an inch on the diameter of the casting which had to come off. The surface was about

sixteen inches wide. The machine was running along very nicely with two large streams of water—I think they figured on about thirty-six quarts a minute—thrown directly on the cuts. There were two cuts, one on the top and one on the side. The chips were turning blue when they came out of the water. I stood watching it and I said to the operator, "Fred, if we turn the water off, what will happen?" He said, "It will burn the tools." "Well, let's shut it off and see," I replied. So we shut down on the water and the machine made one-half of one revolution and the belt went off. We thought we had a broken tool; that a tool had burned. We backed the machine out and the tools were just as they were before. They had not run far enough to be destroyed. So we started the machine with the water and it went along easily and comfortably, and then we cut the water off again. It went less than half a revolution. I tried that enough times to convince me that there was something there I did not understand. I had always thought that lubricant simply made the tools last longer. I did not know that there

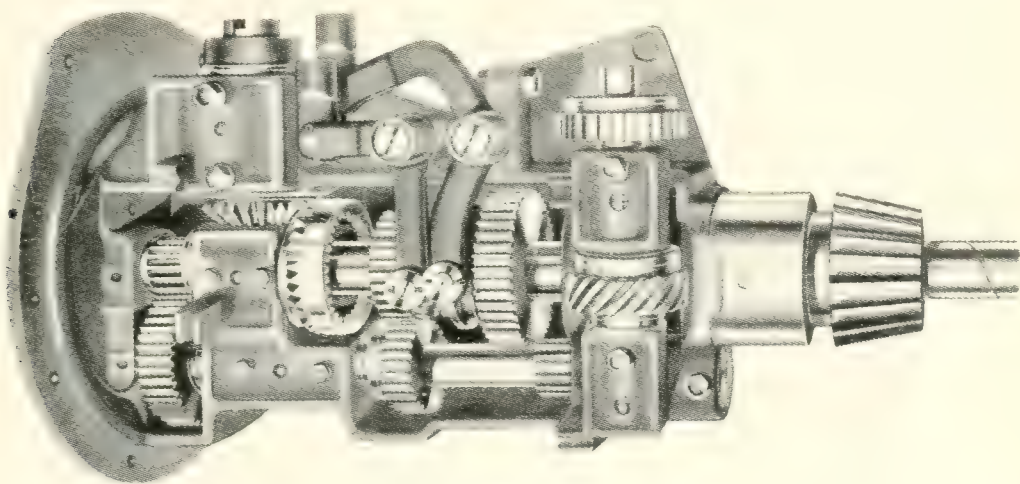


FIG. 4

was any appreciable difference in power consumption, so we brought a motor to the machine and attached a recording watt meter and went at the proposition in such a manner that we could find out what was happening, and after experimenting for several days—which represented all the time we had—we satisfied ourselves that on that heavy cutting there was a difference of 43 per cent in the power required to machine that piece with and without cutting lubricant. As we came down and tried lighter cuts we found, of course, less difference. But there was 43 per cent, gentlemen, on that particular piece, and it is an item, because we have to pay coal bills and we also have to pay for tools that we burn up. Under those conditions it does not pay us to generate too much heat or to keep on generating any unless means are provided to absorb it in a cutting lubricant.

Further experiments along that same line showed us that pieces which we turned without lubricant became so heated that it was not only difficult to handle them, but the dimensions were all out. A hole 15 inches in diameter, when the piece was cold,

became 15 inches plus 0.009 inch when a slight racing cut was taken across the top of the casting. Had we taken our measurements of the piece when it was hot they would have been incorrect and we should have had to make an allowance for heat, and the allowance for heat is an unknown quantity, depending entirely upon the shape of the piece and the amount of heat which we generate. I believe that not only will we turn all steel with cutting lubricant in the future, but I believe that we will turn cast iron with cutting lubricant. We have tried that in our works and it is not such a foolish thing as you might think. We had some large castings which had to be accurate and which got very warm in roughing out; consequently the error was an unknown quantity. We found that by using cutting lubricant we kept the piece cool and eliminated the possibility of error. Cutting lubricant is a thing you will have to deal with. It will represent an investment which is a wise one and you will find that production will be increased by the investment, particularly when you come to turn alloy steel.

We will now take up the question of durability. What are we going to do to make our machines stand up? As we go around our shops we find a machine "down" here and there. Now what are we going to do to make them stand up? We cannot do it by using the carbon steels. Automobiles would not run today, gentlemen, if they depended upon the steel which went into automobiles ten years ago. We must use alloy steel. This is not the age of steel any more; it is the age of alloy steel. We have come to a point where the alloys introduced into steel give qualities which we never dreamed of. You can take a piece of chrome nickel alloy steel and you can form a gear blank of it, and after heat treating it you can hammer one of the teeth over against one of its fellows without breakage. You cannot do that with a piece of cast iron. Now why? Look at your physical tests with alloy steel—240,000 to 245,000 lbs. elastic limit, 260,000 to 270,000 lbs. tensile strength. From this grade of steel we can produce a class of goods guaranteed to give certain fixed results. Such steel is not expensive. You cannot measure the value by the pound. Its value is unknown. You can get wonderful results from the use of this material, and when we use this material throughout in machine tools, gentlemen, you will be as independent as the oil trust. You will not even have to go into your shops, because everything will run smoothly. There is no question about the value of this material. I do not want to bore you about it, but I have tremendous respect for the men who have developed it. We have all got to use it.

There is another material that we have today that we did not have ten years ago. We can get beautiful steel castings. We can today get castings made of steel that can run almost as good as gray iron castings, and the steel castings are infinitely stronger, and we can buy them on a chemical and physical analysis. If we want 40 carbon, just tell the foundryman and he can give it to us.

About a year ago I was in a machinery dealer's store looking at a very handsome machine. It was beautifully painted and

beautifully polished. Every detail had been taken care of. I noticed a little round disc about as large as a 25 cent piece which said "Oil here". I commenced to look over the machine and I found one hundred and fourteen of them. There were one hundred and fourteen holes on that machine that required attention. A man had to go around every morning with a squirt can and oil those holes. There are one hundred and fourteen chances to one that he will miss *one*, and it may be the most important one on the whole machine. There is that chance you cannot get away from.

Now, that set me to thinking, and I went home and happened to think of my old automobile. I used to have one years ago and I had to go over it about every twenty miles and take a squirt can of oil and give it to the engine, and it did not make any difference how much I put in the rear axle, it would not stay there anyway. Those were the instructions on that car. I had a later car which pumped oil into the engine; it pumped oil up through the machine and back again, and it certainly struck me as being about the perfection of lubrication. And so, naturally, we went into studying that problem on our machine, and today I am convinced that forced lubrication, not squirt-can lubrication, is one of the elements in machine design which we have got to consider. I believe that five years from now all machine tools will be so lubricated. It is obvious we cannot get away from it. There is no amount of criticism that will prevent its being done. The objection which is raised that the oil will get dirty has no foundation. You can filter it if you want to. You can pump it up into your machine, distribute it to the running parts, and you will be surprised, gentlemen, to see the efficiency of the machine so lubricated. I think it is a fair assertion to make that with properly proportioned bearings, so lubricated that the two metals cannot come in contact with each other, the film of oil being maintained by a fresh supply, the life of the machine is prolonged indefinitely.

I have produced machines, gentlemen, that I fully expect to run a hundred years and not wear out. They will become out of date, but will not wear out in the parts taken care of by that system. We have not perfected the system, perhaps, but that is one of the features that is going to be developed.

Another factor in durability is, limited belt speeds. There are limits to everything. Belts are efficient up to a certain point, and when you run them faster than that they cease to be efficient and larger belts are required. Some of you may argue that you do not believe in belts; that you want the machines motor driven. Very well, reasonable speed still holds good. We all prefer moderate speed motors. We do not want our gears running like buzz saws. Gears can run comfortably and easily and still do their work. This applies just as well to a machine tool as to an automobile.

Another word about excess belt power. You do not want to be right up to your limit in anything. If you erect a building you want to have a factor of safety in that building. Should you not have that same reasonable factor in your belts? A

factor which will give your belts longer life and give you larger results. Your belt need not be so tight if it is large enough, and this has its effect on bearings also.

A further word about limited gear speeds. I was in an office the other day where they had, I think they said, twenty-eight noiseless typewriters. I do not know anything about the typewriter itself or its efficiency, but certainly it was very nice to have the office so quiet. There was not that continual click, and I believe the noiseless typewriter will come for that reason. Gears running above 600 feet a minute are liable to be noisy, whereas gears running less than 600 peripheral feet a minute will be quiet. Our text books tell us that gears can be operated 1,200 feet per minute. Our automobile men run them up to 2,000 feet at times, but they have to run on a low gear and run on the maximum engine speed.

I know my time is limited and I do not want to take too much of it. I gave as the first two essentials of machine tool design productibility and durability. I now want to take up adaptability. Now, under this, the first point is adaptability to your work. The tool equipment must be universal equipment. We are not considering a special machine purchased for a special purpose. Therefore, the tool equipment, as I say, should be a universal tool equipment; it should be a standard tool equipment purchased from the maker of the machine. Secondly, ease of setting up. If the total time for doing a piece is an hour and a man has to spend half an hour setting it up there is inefficiency. Now, how to save on that setting-up time; how can it be reduced? By getting machines which, when you turn a lever, will go ahead as you direct. That machine which can be controlled will be adaptable because of the ability to set it up for each job in the shortest possible time; it will be efficient in that respect. And how shall we save time between cuts? What is the use of cuts at high speed, ripping things to pieces, and then losing all we gain because we cannot cut the time between cuts? To cut your costs properly, you must cut the time between cuts. Losing time between cuts is exactly like that idle freight car which they say is in use but two hours out of the twenty-four. This is where you can make big savings in your shop because it is the time lost which you can save by using a machine which is so controlled that the changes of speed, changes of feed and everything required to put the machine into operation, can be performed in the shortest possible time. If you have all these features you will save time between cuts.

Boiling this down, gentlemen, if you can get machine tools in your plants complying with these three essentials which I have given you, you will have machines which will give you maximum production with minimum cost; they will have a maximum life with a minimum maintenance charge; they will be efficient machine tools. And I believe they are coming; I expect to buy them and I expect to make them. I think the concern that does not put heat-treated alloy steel gears into its machines will have to change its methods, or stop; I think the concern that does not adopt forced lubrication will in time have to stop. They will

have to change their methods and get into this new line or they will not be in anything. There are machine tool concerns that are complaining of keen competition, and the product they have to sell is not worth buying. It is hard to get the product of the manufacturers who are keeping up to date. People want it; it cannot be had on the market today.

A number of years ago it was my privilege to attend a banquet in Glasgow, Scotland. The banquet was given by the staff of a large engineering firm. They had at that time some four thousand or five thousand men. They gave the banquet in honor of the head of the concern, a man who had made a name for himself and built up an enormous industry. They requested the sales manager to say a few words about the old gentleman. The banquet was a typical Scotch banquet. They had plenty of refreshments of a typical Scotch character, so that when the sales manager's turn came to make a few remarks about the head of their firm he was somewhat under the influence of something they had at the table—I don't know what it was. He stood up with difficulty and could not seem to find his bearings. He spoke about the old gentleman, but he did not get any exact ideas into his head. Finally it dawned on him that the old gentleman had made a very fine pump, and the way he talked about that! You couldn't stop him! If there is anything I dislike to talk it is catalog, and I do not want to come here tonight and give you the impression that I am working up a sales proposition, for I am not. My sales organization probably would not appreciate the fact that I told you not to buy any machines not equipped with power operated heavy parts. But I have brought one of these pamphlets just to illustrate how I worked out these ideas in my own work. See Fig. 1. I want you to note that the machine has an eyebolt in the top of it with which to lift it. When you look at the machine and realize that it weighs 14,000 lbs., you will appreciate that not every shop man can properly sling it. Now, why shouldn't we provide an eye at the center of gravity so that the crane can take hold of it?

You will note Fig. 2 is a disc clutch. I believe, gentlemen, that is the most important part of the machine, as I have explained, and the disc, as we have worked it out, seems to give the service we expect.

Fig. 3 shows a primary power transmission.

The gears in this case are of chrome nickel steel, of which we have had test pieces show as high as 260,000 lbs. tensile and 245,000 lbs. elastic. I am proud to say that I have yet to hear of a gear failure.

Fig. 4 shows the secondary power transmission. In this you will find an opportunity to verify one of the theories which I have that all shafts should be short and the length between bearings should be limited. You will notice that the gears in this case are closely supported and the bearings are ample. The gears we have in the primary case are of chrome nickel heat-treated steel. Both of those mechanisms are immersed entirely in oil supplied by a pump located in the base of the machine which is direct-connected to the first motion of main pulley shaft,

and is, therefore, in operation as long as the main pulley is in motion.

There are many things that may be developed. We do not know what they are; we will have to use our knowledge as we gain it.

I thank you, gentlemen, for your attention and regret that I have taken so much time, as I feel, with the old Methodist minister, that "there are very few souls saved after the first twenty minutes."

Discussion

MR. H. M. LUCAS:—

I was very much interested in Mr. Bullard's talk. I believe he is right in his prophecy that this advanced construction is coming and we should get in line to adopt it. I think the machine, which he has been too modest to say very much about and which is shown in the circular handed to us, embodies all these advanced features about which he has been telling us. It is well known that Mr. Bullard, and the concern of which he is the head, are pioneers in the line of this advanced construction. I believe the difficulties of applying this construction are not as great as the difficulties in educating the users to make proper use of the machines after they have been supplied, and to educate the purchasing agent to be willing to pay for these advanced features. In visiting concerns with which we do business, I have been impressed with the fact that a good many high-powered and up-to-date machines are not being used at all as they should be, or up to their capacity. For instance, I have seen big, high-powered milling machines more often working on small work, such as could be done on a much lighter machine, than on work for which they were really designed. I believe it will be easier for the machine builders to swing into line and make machines embodying these improved features than it will be to educate the users to get the best possible out of them and to educate the purchasing agents to be willing to pay for their additional cost.

MR. S. T. WELLMAN:

I have been very much interested in Mr. Bullard's remarks and I do not know that I can add anything. I am getting to be rather a back number. Things have been going so fast that I have not been able to keep up with them, but I was very much struck with one thing Mr. Bullard mentioned, and that is the question of cutting speeds. If you gentlemen will compare the cutting speeds that he talks of with those that some of you are using in your shops, and see what it would mean in the difference of output, you will be very much surprised. Of course this has been brought about very largely by the development of the high-speed tool steel which has come

in the last few years, and has resulted in much heavier and stronger machines than the old fashioned ones. I should like to have Mr. Bullard tell us again, if he will, the highest cutting speeds that he thinks possible with different materials, brass, cast iron and steel.

MR. E. P. BULLARD:—

That is rather a difficult question, Mr. Wellman. Of course, it depends a great deal on conditions. In the instance I spoke of I saw a cut taken on steel which was said to be 40 carbon steel, and the chips came off red. The speed was just over 400 feet a minute. It cut like wood. I have frequently seen in our own shop speeds of 300 feet on finishing cuts preparatory to grinding. The turning of steel castings is, of course, a more difficult problem, but speeds of 65, 70, 80 and 90 feet per minute are possible. The two finishing cuts that I saw taken inside of a cylinder were made at a speed of 150 feet $1\frac{1}{8}$ inch wide, $1/32$ deep, on a machine with two heads. A year ago I was at the Bath Iron Works and saw them turning a piece there. It happened to be 40 inches across the corners. They were running, I should say, 25 feet. I talked with the manager and said that I thought a higher speed was permissible. It was hard bronze, and he said, "How high do you think we can go?" I said "I do not know." We started the machine and turned it at 600 feet a minute.

I do not believe there is any known limit to cutting speeds. We are taking higher speeds on an average than we did ten years ago, and I do not know but that we may go still higher.

MR. H. M. LUCAS:—

I would like to ask Mr. Bullard what are the limits of pressure per unit of area which he uses for bearings.

MR. E. P. BULLARD:—

We try to keep inside of 25 lbs. per square inch normal; maximum, 50 lbs. We may sometimes run over that on account of the difficulty of calculating pressure. The ordinary boring machine of our design is probably running at less than 10 lbs. per square inch. We try to maintain very low pressures, but that is possible in machine tools which would not always be possible with other machines.

MR. J. H. HERRON:—

I believe that Mr. Bullard is right in saying that all machine tools must sooner or later come to the use of steel gears. When we consider the limited carrying capacity of a cast iron gear and compare it with the carrying capacity of a steel gear, we are surprised that the adoption of the latter has not been

more general. The normal carbon steel gear has a value of perhaps three to one, compared with the cast iron gear, and the normal alloy steel gear has about twice the value of the normal carbon steel gear. By heat treating either of these, the value of the treated gear is about twice that of the normal gear. Therefore, the value of the treated gear can be easily compared with the value of a cast iron gear.

As the desire for increased production grows, it is necessary to combine maximum strength with ease of handling. This can be done only by the use of material of a greater strength than has formerly been used. Steel gears are, therefore, a step in the right direction.

Mr. Bullard did not mention the fact that the best results for the service seem to be obtained from the thru hard gear, which is not hard in the sense that we sometimes understand it, i. e., "file hard". The carbon content of the material is sufficiently high so that it will toughen. Case hardened gears are frequently used, but such material would not stand the test Mr. Bullard has spoken of, in bending one tooth over against its fellow. The thru hard gear is practically indestructible, owing to the toughness of the entire mass. Such gears running under the proper conditions are subject to very little wear. I have seen an effort made to break a tooth of a thru hard gear with a heavy hand hammer, and while the tooth was battered out of shape, it could not be broken, but could be battered back again into shape; to break the gear it was necessary to resort to an hydraulic press.

MR. A. J. HIMES:—

I am unable to say very much about machinery, but I was quite interested in Mr. Bullard's comments about his talk with the superintendent who was sure that he could not do a certain thing. It is very common to bring up a problem that is new and be told flatly that it cannot be done without any attempt being made to say how or why it cannot be done. We encounter this thing frequently and are not always met in a fair-minded, candid spirit. It is always essential that an engineer think of such things in a reasonable light, and, as Mr. Bullard did, inquire what the particular reason is that the thing cannot be done; to seek for the cause, and, having found it, he is in position to proceed with its elimination.

In this line it is of great interest to learn that the Case School is teaching its students logic. I think we have relied too much upon our mathematical training and neglected the development of our reasoning powers.

THE NEW ERA IN MACHINE TOOL DESIGN.

American Engineer and Railroad Journal, Jan., 1910—Boring and Turning Mills. Illustrates and describes a new line of vertical mills, in five sizes, brought out by the Colburn Co.

American Machinist, Nov. 12, 1908—A Large, Vertical, Cylinder Boring Machine, by Philip Bellows. Describes a special design, equipped with friction drive.

American Society of Mechanical Engineers, June, 1903—Description of Sixty-Foot Vertical Boring and Turning Mill Designed by John Riddell for General Electric Co.

Engineering, July 17, 1908—Vertical Turning and Boring Mill at the Franco-British Exhibition, by Joseph Horner. Illustrates and describes a 4-foot mill having novel features; notably a chain-drive to a worm which turns the table.

—May 6, 1910—Vertical Boring and Turning Machine. Illustrated description of a machine shown at the Brussels exhibition.

International Library of Technology—V. 1 B, p. 23. Vertical Boring Machine. The introductory remarks on boring machines refer briefly to their origin.

Iron Age, Dec. 30, 1909—A New Colburn 30-inch Vertical Boring Mill. Illustrated detailed description.

Moore, S. H.—The Vertical Boring and Turning Mill. In his *Mechanical Engineering and Machine Shop Practice*. 1908. p. 223-5. Function, description of parts, and characteristic operations.

Werkat-Technik, Sept. 1, 1912—Tests of a Vertical Boring Mill, by S. Streiff. Gives results of tests of a Floriep mill on iron and steel, with cutting speeds up to 82 feet per minute; shows influence of feed on power requirements.

For earlier designs of vertical boring machine consult the files of the *American Machinist*.

The Electrification of Steam Railways

By N. W. STORER.

A discussion of the subject selected for this meeting is one which almost invariably arouses the greatest interest. It is not because it is an electrical subject nor because it is about railways. It is because it is a subject that concerns every one who travels, for all such men have been subjected to the discomfort of riding behind a steam locomotive and are interested in everything that offers an improvement. Mr. Dooley says that any one may experience all the delights of riding in a sleeping car without leaving home. His advice is: "Throw a \$2.00 bill out of the window, put a cinder in your eye and spend the night on the top shelf of your darkest closet." This is probably a slight exaggeration of the joys of present-day traveling, not due entirely to the steam locomotive, and although only the cinder and its attendant smoke and dirt can be eliminated from this picture by the use of the electric locomotive, most people are anxious to have the steam engine discarded even before they have seen an electric locomotive. When one has experienced the happiness of riding behind an electric on a hot day in the summer with all windows up and no smoke and cinders, he is ever after a convert to the electric.

The belief in the unbounded possibility of electricity has led to the idea that it is only a matter of a few years before all the steam locomotives will be relegated to the scrap heap. I used to share the belief, but the more I learn of the subject, the more respect I have for the steam locomotive and the work it is daily performing, and the greater the task of supplanting it with the electric appears to be; not that we are doubtful as to the ability of the electric locomotive to do the work, for we are certain that almost any railway can handle more traffic and do it better when operated by electricity than by steam. What, then, is the reason for doubting the speedy and general substitution of electricity for steam? Simply that the traffic on most railways at the present time would not pay for the large initial investment necessary for operating it by electricity.

A steam locomotive is an independent power unit requiring supplies only of fuel and water at intervals along the road. The electric locomotive is in itself powerless. It must have a power house back of it, with transmission lines to carry the power to it wherever it may be.

As the electric locomotive itself is much more expensive than the steam engine, and the power house and distribution system cost a great deal more, the investment for operating a heavy railroad by electricity must, therefore, be relatively very large, and unless the frequency of trains is high enough to maintain a

good load factor on the line, sub-stations and power house, it can scarcely pay. In other words, electric operation will pay if you can keep the apparatus working a reasonable percentage of the time, but will not pay if the percentage is small. A bank cannot pay interest on deposits when 90 per cent of them are locked up in the safe. Similarly, a man who has a high priced automobile that is run only 1,000 miles per annum, is paying a very high price per mile; much higher than the man whose machine covers 10,000 miles. Any apparatus must be used in order to make it pay for itself.

In comparing the cost of electric with steam locomotives, one railway official went so far as to say that the electric locomotives used to haul their trains cost not \$35,000.00 each, which was the contract price for them, but \$100,000.00 each, which was the cost of the entire installation, divided by the number of locomotives. This might appear to be the case, but it is not strictly correct, unless the cost of all the roundhouses, machine shops, coal handling and distributing apparatus, water tanks, etc., be included in the cost of the steam locomotives. Even that, however, would leave the cost of the latter motive power only a fraction of that of the electric. Under such a handicap, it cannot be expected that the railroads, which are laboring under great financial difficulties at the present time, will be able to electrify their lines except under conditions that absolutely require it or offer exceptional advantages.

Compulsory conditions are sometimes imposed by legislation to force a railroad to electrify to abate the danger and discomfort of operating steam locomotives through long tunnels. This was the immediate cause of the adoption of electricity as a motive power by the New York Central and the New Haven railroads, for the entrance to New York City. This electrification cost a tremendous amount, but it has resulted in a most magnificent terminal, increased comfort and safety to the traveling public, and last but not least, in increased value of real estate owned by the railroads, which bid fair to make the electrification a paying investment. If this last proves to be really true, it will be most important, as it will make electrification much more attractive to the far-seeing railway officials and will result eventually in the electrification of the terminals in all the large cities.

Beginning with the B. & O. R. R. at Baltimore, in 1895, a number of railroads have electrified tunnels which were a constant menace to the health and lives of the passengers and train crews. The St. Clair tunnel of the Grand Trunk railway was electrified in 1906, and since then the Detroit river tunnel of the Michigan Central, the Cascade tunnel of the Great Northern, the Hoosac of the Boston & Maine, the Pennsylvania tunnel leading to the great terminal in New York City, have all been electrified in this country and are operating with great success, handling both passenger trains and the heaviest freight trains on both heavy grades and level track. These tunnels, in all of which, except the Pennsylvania, steam engines were originally operated, will be remembered by travelers as the places where every one was formerly nearly stifled. Now, either in the hottest summer day or

the coldest of winter weather, the tunnel is welcomed as being the most comfortable part of the ride.

Another phase of the situation that is now receiving a great deal of attention is on the mountain grades where the heavy freight trains crawl up at from 5 to 10 miles per hour, and the passenger trains crawl up at from 10 to 20 miles per hour. These grades always form the "neck of the bottle", and limit the amount of traffic that can be handled by an entire road. Even if it cost a great deal more to operate such grades by electricity, it would pay large dividends on the investment by increasing the capacity of the entire road.

Some one may wish to inquire how this electrification will increase the capacity of the entire road. It is effected by increasing the speed both on the up grade and the down grade, and by the greater reliability of service. On electrified divisions, the heaviest freight trains of 2,000 to 3,000 tons trailing load can readily be hauled up a grade of 2 per cent by electric locomotives at speeds of 15 to 20 miles per hour, while the speed with steam locomotives would be usually from 5 to 8 miles per hour. This is possible because the electric locomotive has the power house back of it, but does not have to haul it up the hill. At speeds of 15 to 20 miles per hour it will have all the weight on drivers, and usually only as much as is necessary for adhesion. This being the case it can haul the trains at 20 miles per hour just as efficiently as at 10 miles per hour.

The steam engine, on the other hand, must haul its entire power plant up with it, and consequently, the higher the speed at which it operates up a grade, the less load it can pull, so that the economical speed is very soon reached. This appears to be 10 miles per hour, or less, for a 2 per cent grade with heavy freight trains.

As the electric locomotive can take a train up a heavy grade much faster on account of its greater power, so it can take a train down the grade at a much higher speed because the motors can hold the train from accelerating by regenerating power and putting it back into the line to help some other train up the grade, or by using it up in a resistance on the locomotive. This saves the brake shoes for use in stopping the train only and thereby eliminates a great deal of the danger of taking trains down grades. Incidentally, the saving in power may be as much as 25 per cent, and the saving in brake shoes and general wear and tear of the equipment will also amount to a considerable item.

We, therefore, have the greatest confidence in inviting the attention of railroad officials to the electrification of their mountain grades, for if the traffic is at all congested there, electrification is bound not only to improve the service, but to give a very substantial return on the investment. The electrification work that has already been done is enough to show that electric locomotives can handle any kind of service from the heaviest slow speed freight service to the fastest of heavy passenger work.

The next question is, when will the great lengths of line between the terminals, and connecting terminals and grades, be

electrified? That is something that will depend entirely upon the territory through which the road passes and the population of the terminals. I regard it as entirely possible, if not highly probable, that within the next ten years one can travel from Boston to Washington by fast trains over the New York, New Haven & Hartford and the Pennsylvania railroads, behind electric locomotives. The New Haven is now operating all trains between New York and Stamford by electricity and is rapidly extending its electrification to New Haven. It is also working at the Boston end of the line between Boston and Providence, besides having its Harlem river division and its immense freight classification yards operated exclusively by electricity.

The Pennsylvania has the vast network of lines on Long Island, besides the New York terminal, operated by electricity. It is now working on the Philadelphia terminal which must be electrified in order to increase its capacity. The bad tunnel at Baltimore must be electrified and the terminal at Washington must soon follow. With these city terminals all electrified, it is a foregone conclusion that the whole distance from New York to Washington will be equipped, as it would be impractical to have any breaks in the service; aside from this consideration, however, I believe that the population is so large as to make it a paying investment anyway.

Similar results will follow in other sections of the country, but more slowly and only as it is found by the railroads to pay a good return on the investment. That is the only thing that will make general electrification possible. No matter how desirable it would be to the public the railroads cannot electrify until it can be made to pay, either at present rates for freight and passenger service or by the undesirable alternative of higher rates for the improved service.

Just a word to people who are for compelling the railroads to electrify their terminals in large cities. Don't do it. The railroads in this country are fully alive to the advantages of the electrification for such situations; or if not now, they soon will be, for they are all studying the subject with the greatest care. I believe the matter can be safely left in their hands for a few years, at least, until the necessary plans can be made and all the innumerable details connected with the adoption of the new motive power are fully worked out. Without this careful consideration, the plans will be only half baked, and vast sums of money will be wasted and the full advantages of electrification will not be secured. When the railways of any city decide to electrify the terminals, they should work out a harmonious plan that will include all of them, so that power may be furnished from a common power house, and all equipment be interchangeable.

Electrification is bound to come on a large part of the railroads sooner or later in any case, but the steam railways should not be forced into it until they have had ample time to mature their plans.

There are many, many advantages from it, some of which are only beginning to be understood and some of which have never had the correct value. When all have been shown by

experience to have certain definite values, and the best way to secure the advantages has been thoroughly worked out, the railroads will need no compulsion.



FIG. 1. 110-TON, 1,500-H. P., 11,000-V., SINGLE PHASE LOCOMOTIVE,
DESIGNED FOR HAULING 1,500-TON FREIGHT TRAINS AT
35 MILES PER HOUR, OR 800-TON PASSENGER
TRAINS AT 45 TO 50 MILES PER HOUR.

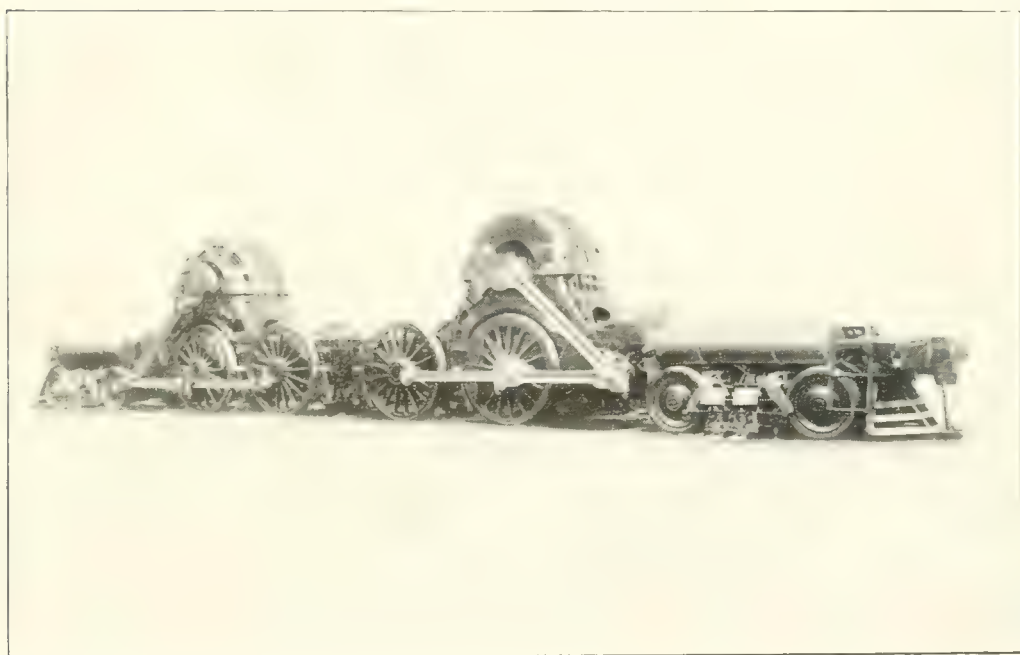


FIG. 2. RUNNING GEAR AND MOTORS FOR PENNSYLVANIA LOCOMOTIVE.

Following the foregoing paper, Mr. Storer presented a number of lantern slides showing various types of electric locomotives and discussed their salient features. Prominent among the list were the locomotives of the New York, New Haven & Hartford, the Pennsylvania, the St. Clair tunnel, the Boston & Maine and several European types. In general, the types were shown to exhibit the various forms of connections between the motors and the driving wheels, and to show the disposition of the weight, and the arrangement of wheels as affecting the riding qualities of the locomotive. The different forms of transmission between motors and driving wheels were distributed as follows:

1st. Gearing motors directly to the axles as on the ordinary street car. Among the locomotives of this type shown was one experimental locomotive for the Pennsylvania railroad, the St. Clair tunnel and the Spokane & Inland, all being suitable for service at speeds below 30 miles per hour.

Operating with this type of locomotive with heavy motors mounted directly on the axle, is confined to low speeds because of the effect upon the track on account of the dead weight on the axle and the low center of gravity.

2nd. The locomotive having the motors mounted on a hollow shaft surrounding the axle; these hollow shafts or quills being connected to the wheels through the springs. The early New Haven passenger locomotives were of this type and have been quite successful, although some trouble was experienced with them after a few months of operation, on account of nosing. This was overcome by the addition of pony wheels at each end of the locomotive and the use of a toothed cam centering device.

This type of locomotive is very successful as long as the track is kept in good surface, for, in spite of the low center of gravity, the motors are entirely spring borne, so that a direct shock is very seldom given to the track.

3rd. The third type of locomotive exhibited had the motors geared to the quill surrounding the axle, which is connected to the driving wheels through long flexible springs which permit the motor and quill to move a total distance of 3 inches in a vertical direction with respect to the axle. It is, therefore, possible to mount the motors directly on the truck frame. This form of locomotive is made for the New York, New Haven & Hartford, with both one motor per axle and with twin motors. Where one large motor is used, it is necessary to have double gears which require very accurate alignment. Where twin motors are used, only one gear is required and both of the motors drive through the same gear. The small motors are found to be less expensive for single phase work and are lighter and easier to handle. On the New Haven railroad, the same motors are used for both locomotives and multiple unit cars, excepting, of course, the motor frames which have to be adapted for a different type of mounting. This type of locomotive gives high center of gravity and is an exceptionally easy riding machine. All of the weight above the

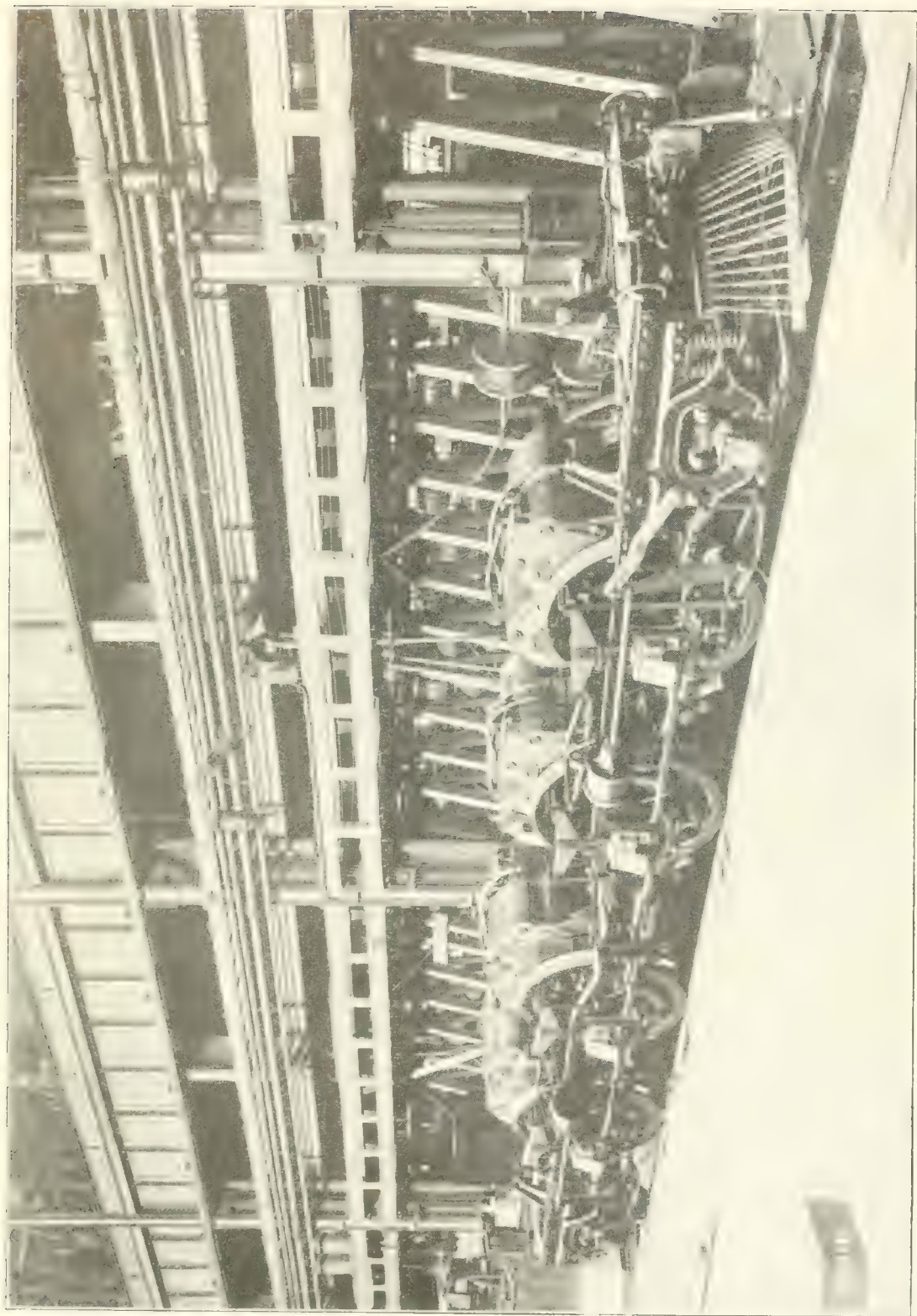


FIG. 3. RUNNING GEAR, SHOWING THE FOUR PAIRS OF TWIN MOTORS OF N. Y., N. H. & H. LOCOMOTIVE 076.

wheels and axles is spring borne, and there being absolutely no tendency for nosing, the machine is very easy on the track and is very comfortable to ride in.

Locomotives for both heavy freight and passenger work and for switching service with this type of drive were shown. It has been adopted as a standard by the New York, New Haven & Hartford, which has purchased over sixty locomotives of this type.

4th. Locomotives with motors mounted high in the cab and connected to the driving wheels through parallel rods from the motor to a jack shaft on the same level as the driving axles and thence to the drive-wheels by other parallel rods. The principal locomotive of this type which has been built is that of the Penn-



FIG. 4. 160-TON, 600-V., D. C. LOCOMOTIVE WHICH HAULS 800-TON PASSENGER TRAINS UP THE 2 PER CENT GRADE INTO THE PENNSYLVANIA TERMINAL IN NEW YORK CITY.

sylvania for use in the New York terminal. This is probably the most powerful electric locomotive ever built. It is used to haul trains of more than 800 tons weight up a 2 per cent grade into the station. The locomotive weighs about 160 tons and has exerted a drawbar pull on level track of nearly 80,000 pounds. It is also able to handle the heavy passenger trains at 60 miles per hour on level track. This type of locomotive has the highest center of gravity of any that have been built, and its operation on the track is similar to that of the best steam locomotives. A few years ago this would not have been considered very good by electrical engineers, but sad experience with machines having low center of gravity has modified their opinions to a great extent and

they are now glad to claim that such locomotives are as good as the best steam locomotives. This locomotive has established a wonderful record for reliability, there being only thirteen train minutes delay charged against the locomotives in the first year's operation. Such a record with 33 locomotives is little short of marvelous.

Another type of locomotive exhibited was that of the Italian State railways, which connects the motors to the driving axles through a Scotch yoke. This is a form of side rod which is quite satisfactory for slow and moderate speed service. It has never been used for high speeds.

Another type is a combination of gears and side rods. This form is used for the locomotive built by the Oerlikon Company, in Switzerland, for the Loetichberg tunnel. The motors are geared to a jack shaft, instead of connecting to the latter by means of parallel rods as in the case of the Pennsylvania locomotives. This permits the use of a much higher speed motor and a considerable reduction in the weight and cost of the locomotive. It also enables the use of a single design of motor for various speeds of locomotives which may be secured by simply changing the gear reduction.

Some of the principal advantages of electric locomotives were discussed briefly and Mr. Storer expressed himself as being opposed to the extremely high wheel loads which are being used with the latest types of steam locomotives, and advocated the use of electric locomotives with wheel loads about equal to the maximum wheel loads on freight or passenger cars. It is claimed by many engineers that the destruction to the track is due almost entirely to the locomotives. These heavy wheel loads are probably necessary for the tremendous units that are now demanded, but the use of electric locomotives will permit the weight to be distributed so that no locomotive wheel need carry more weight than a car wheel in the same train. This will give the best possible results on the roadbed and will give more flexibility in locomotive units.

Following this a considerable number of lantern slides were presented, showing various forms of overhead line construction in use on the New York, New Haven & Hartford railroad. These included photographs of the Harlem river yards, the main line with from four to six tracks, and the construction on the New York, Westchester & Boston double-track line.

Discussion

MR. WILLARD BEAHAN:—

I studied engineering before electricity came into use. The great difficulty, as I see it today, is to make the money which we might spend electrifying our lines—to make our lines earn any reasonable per cent. That, as I understand it, is the difficulty which we steam railroaders face.

The speaker has pointed out the fact that however much we may desire electrification, or better railway facilities, no matter how many enthusiastic meetings we have, if we cannot show the financial interest—some reasonable dividends—our legislation amounts to nothing. You cannot compel a man to buy a bond just because you have passed a resolution to that effect. It is all futile unless you can show something that is really worth while, and I am very much impressed, and am very thankful to the speaker for his fairness of mind in approaching the subject from that standpoint.

MR. E. P. ROBERTS:—

There are ten railroads in Cleveland, and practically 587 miles of single track in those ten roads; each of them has a different problem to consider. Cleveland is a terminus for some of these roads; for others the city is the central point on the line—it may be a division end. Cleveland is different from some terminal cities, like New York and Chicago, in view of the fact that it has but little suburban service on the steam roads. The freight traffic is very large and the switching much greater than is generally realized, and it is rapidly growing.

I am very glad Mr. Storer showed those pictures of the yard. Some of my steam railroad friends have questioned the practicability of fitting up yards for electrical operation. Of the approximately 587 miles referred to, probably three-fourths of this track-age is in yards.

MR. ROBERT HOFFMANN:—

As a citizen of Cleveland, the subject of tonight's paper is of great interest to me. At some of this city's grade crossing elimination negotiations with the city council, the electrification of railways was discussed, with the view of incorporating in the ordinance the requirement to use electricity as the motive power. Contradictory claims were made regarding the feasibility of electrifying. The matter was finally dropped on the score that it would be both a financial hardship and impossible of enforcement under existing laws. No definite information regarding the increased cost of electric equipment over use of steam locomotives was available at that time, and it is gratifying to learn that more exact data is now at hand, and that railway companies are recognizing the desirability of adopting electric locomotives under certain conditions. It seems only fair that the financial burden of changing to electricity should always be given due consideration by city authorities when endeavoring to force such change upon the railway companies.

MR. W. M. RAY:—

The general officers of the B. & O. R. R. have been giving much study to the question of increasing the capacity of its mountain divisions. It is found that while traffic increases up to a

certain point, the cost per ton mile decreases; but after the traffic density passes this limit, the cost goes up rapidly, indicating that the economic capacity of the division has been reached. When this condition is found recurring frequently, it is up to the road to relieve the congestion. Of course, there are other means than electrification for getting at the trouble. Perhaps increased track facilities will solve the problem or possibly the grades can be lowered.

With regard to the situation in cities, Mr. Roberts has said there are some ten railroads entering Cleveland, and it is apparent to everyone that the conditions on each line are different; that is, whether the freight is coming to the city or going out, and the topographical surroundings of the roads. I suppose it is for that reason the roads have so dreaded municipal legislation. They are not hostile to electricity, but they do dread blanket legislation for all roads with very different problems to face.

MR. W. H. ABBOTT:—

One point which we, as engineers, have all been worrying about, is the question of system; I think if we, as engineers, could once make up our minds that we wanted direct current, or alternating, we would then feel that the problem was three-fourths solved. I should like to hear from Mr. Storer, if he is in an impartial attitude tonight, as to alternating current or direct current.

MR. N. W. STORER:—

That is rather a leading question. It is generally recognized among the electrical fraternity at the present time that there has been entirely too much discussion about the system used for electrification. The fact is that there are several systems now in successful use. The three-phase locomotives in Italy, which have a constant speed characteristic, are giving excellent results on the Italian State Railways. The State Railways of Germany and Switzerland are committed to the single-phase system. They use 15,000-volt, 15-cycle, single-phase alternating current on an overhead wire. In France they are electrifying the Midi Railway with single-phase current at 16-2/3 cycles. They are also doing some terminal electrification with direct current. In England there is some single-phase work and some direct current; the latter at 600 volts. In this country we have at present in use direct current at 600, 1,200 and 1,500 volts, with several lines projected at 2,400 volts. There is single phase in use at 2,200, 3,300, 6,600 and 11,000 volts. It is, of course, understood that with single-phase system, the overhead voltage can be anything that is desired within the bounds of reason, and practically the only change in the equipment necessary is in the transformer on the car or locomotive, while with direct current a more extensive change is necessary. The New York, New Haven & Hartford Railroad has the most extensive electrification under way at the present time. This is with the single-phase system. As a matter

of fact, railways can be electrified successfully with any of these systems and all have been pretty well tried out in service with the exception of the 2,400-volt direct current. It will be eventually decided on the basis of cost. There is not enough data at hand to settle this at the present time.

MR. A. J. HIMES:—

I would like to ask whether, in case of storms, any serious breakdowns have occurred in overhead systems?

MR. N. W. STORER:—

The storms which have caused trouble have usually been lightning storms. This has for many years been the source of trouble on direct current lines, especially running through country districts. It is controlled quite satisfactorily by the use of lightning arresters, if placed in sufficient numbers along the line. Lightning is very much less liable to cause trouble on the single-phase roads than on the direct current, owing to the fact that the transformer on the car or locomotive offers a perfect protection for the rest of the locomotive. It is very seldom that it gives any trouble on the line.

The catenary construction with steel bridges or poles, which is usually adopted for steam railway electrification, is very strong and is not affected by winds. Sleet storms frequently give trouble on low-voltage lines, as the ice insulates the trolley wheel from the wire so that it cannot make contact. The high voltages that are used on single-phase railways, however, are not affected by this in the least.

MR. W. H. ABBOTT:—

I would like to know whether you do not consider the former New Haven construction could be made much simpler?

MR. N. W. STORER:—

The original New Haven construction was heavy, inflexible and expensive. It has been modified so that the operation is entirely successful. The new construction has been designed with all of the experience gained from the original construction. Its cost is less than half that of the original and it is a better and safer construction. It is well protected from lightning by the grounded steel catenaries which support the entire overhead construction. It is probable that this later construction will be still further simplified. I have no doubt that it will be much simpler and cheaper before the final solution is reached.

In this country, there is no overhead construction for high voltages that compares in cheapness with that in Italy and Germany. The construction there is extremely light and much cheaper than our own. They are apparently satisfied to take more chances

than our American engineers, and are able to take care of a system which would be considered very fussy in this country. Labor is very much cheaper.

MR. W. H. ABBOTT:—

That is in connection with the three-phase roads in Italy; they use a motor with a constant speed characteristic. Has there been any trouble? In this country, the railroads have a habit of getting behind time, and making up time. With a motor that will not speed up, what is the way of surmounting that difficulty? Do they have to make a time table so slow that they can always exceed it, or what is the method of maintaining the schedule?

MR. N. W. STORER:—

Anyone who has been in Italy will agree that the time schedules are very slow. The time tables are made up with a very large allowance for making up time and the consequence is that they are able to give excellent results with the constant speed, three-phase locomotive. It must be understood that the constant speed characteristic really assists materially in keeping the train on time, since it must run at practically the same speed after it once gets started, so that the only time lost will be in accelerating or in accidental delays. Inasmuch as they usually allow two or three minutes at each station, it is not very difficult to keep the trains on time. The three-phase system is entirely satisfactory in Italy, but it will probably never be a popular system here for general electrification.

MR. HOPKINS:—

Some of us are not informed as to what method of heating cars is used in these electric trains. Are there any statistics at all which go to show that there are more accidents with electric driven trains than with steam driven trains? Do the last few years show a greater adoption in steam railroads than in years before that? Is the adoption in steam railways growing proportionately?

MR. N. W. STORER:—

Some railways use electric power for heating trains. Part of them use the current directly in the heaters, as they do in trolley cars in some cities. Others, such as the Pennsylvania Railroad for the New York terminal, use an electric boiler. The current is used on the locomotive for evaporating water which passes back through the train. That is a very expensive method, but is probably very nearly as efficient as when the current is used directly in the heaters. It takes very nearly as much power to heat the train in cold weather as it does to move it.

I do not think there are any statistics to indicate that there

are more accidents from electricity than from steam on railways. In fact, I doubt if there would be as many accidents. On an electric locomotive, the man who takes the place of the steam locomotive fireman is simply an assistant for the engineer and he is able to give his entire time to watching signals, as very little is needed for the care of the apparatus.

Now, as to the progress of electrification on steam railways, it is undoubtedly growing rapidly. The number of railways which have been enumerated tonight are extending their lines and there are new railways constantly being added to the list. What is more important, all of the railways are much interested in the subject and are studying it. There is no doubt that the number of electrified steam railways is increasing; however, when we consider that there are some 50,000 steam locomotives at present in the United States, we must realize that it will take a very long time to replace all of them.

MR. E. P. ROBERTS:—

Can the speaker give us any information as to the condition in Chicago?

MR. STORER:—

I know very little about the Chicago situation. I have been in it in a very general way and know that the commission appointed there has been working hard and very quietly.

ELECTRIFICATION OF STEAM RAILROADS.

American Institute of Electrical Engineers. Proceedings. Apr. 1911—*Electrification Analyzed, and Its Practical Application to Trunk Line Roads, Inclusive of Freight and Passenger Operation*, by William S. Murray. Presents facts concerning trunk line electrification, giving information of interest and value.

—July, 1912—*The Relation of Central Station Generation to Railway Electrification*, by Samuel Insull. Diagrams, discussion and results, comparing unified power supply with the group system for railway purposes.

—August, 1912—*Central Station Electric Power for Railroad Operation*, by Frederic Darlington. Explains the important advantages from centralization of power.

American Institute of Mechanical Engineers. Transactions. July, 1910—*Symposium on Railway Electrification*. Presented at the joint meeting of the British and American Mechanical Engineering Societies. Contents: *Electrification of Suburban Railways; Cost of Electrically-Propelled Suburban Trains; Economies of Railway Electrification; Electrification of Trunk Lines; Electrification of Railways; Discussion.*

Burch, E. P.—*Electric Traction for Railway Trains*, 1911.

- Cassier's Magazine**, March, 1912—Is Electric Traction Coming for Main-Line Railways?
 I.—The Operation of Steam Railroads by Electric Motors, by J. B. Whitehead.
 II.—The Advantages of Steam Over Electricity on Railroads, by Arthur Curran.
 Introduction, with discussion of both sides.
- Engineer** (London), Dec. 15, 1911—The Future of Railway Electrification, by Philip Dawson: Abstract of paper read before the Royal Automobile Club. Considers the adoption in America on main lines and the progress in Europe.
- Engineering Magazine**, Sept. 1909—The Substitution of Electric Power for Steam on America's Railways, by F. Darlington. Expediency of the adoption of electric power by steam lines as a defense against rising competition by trolley roads in the richest traffic territory.
- Feb., 1910—Financial Aspect of the Application of Electric Motive Power to Railroads, by F. Darlington. Discusses the relative economy in both local and long distance traction.
- Engineering News**, Mar. 31, 1910—The Cost of Electric Operation of Steam Railways. Concluding portion of a paper by George Gibbs; in the Bulletin of the International Railway Congress of Jan., 1910. Deals with the design of electric locomotives and with the first cost, and cost of operation of electrified steam railways.
- International Railway Congress Bulletin**, Sept., 1912—The Electrification of the Railways, by Mr. Biedermann. A critical review of a memoir by Oskar Kresse, setting forth the disadvantages of the electrification of the German state railways.
- Journal of the Franklin Institute**, June, 1912—The Electrification of Main-Line Railroads, by W. J. Clark. A general statement of the things electric traction has accomplished, and their bearing upon the electrification of main lines. Discussion.
- Mechanical Engineer**, Dec. 29, 1911—Electrification of Railways, by E. O'Brien. Read before the Manchester Association of Engineers. Discusses conditions required for successful operation, advantages of electric over steam traction, operation, etc. Serial, first part.
- New York Railway Club**. Proceedings. March, 1911—Electrification. Short papers by J. A. McCrea, George T. Swain, H. Gilliam and William McClellan, with general discussion in which many electrical engineers took part.
- Power**, July 4, 1911—Electrification of Hoosac Tunnel, by W. O. Rogers. Illustrated description of the line construction, electric locomotives and plant for supplying the energy.
- Yale Scientific Monthly**, Nov., 1911—Different Types of Railroad Electrification, by C. C. Clise. Brief description of the direct current, three phase, and single-phase systems.

The U. S. Weather Bureau and Its Work

BY WILLIAM H. ALEXANDER, Section Director.

Mr. President and Gentlemen of the Society:—

I am very pleased indeed that your President has so happily indicated to you my part on the program this evening and what you are now to expect, namely, “a spell of weather”. Furthermore, I wish to assure you his generous references are highly appreciated—kind words are not wasted on the weather man. (Laughter.) Bouquets are always refreshing. And so to be with you on this delightful occasion is a real pleasure. I do not assume for one moment, however, that your presence here is in any sense a personal tribute, but rather an evidence of your interest in the topic assigned for discussion; and this, to me, is real cause not only of personal satisfaction, but of serious concern lest my effort fall short of the real merits of the subject and of your interest in the same. My regret, therefore, is that the matter is not in abler and more eloquent hands, for I may as well tell you now what you will soon discover, namely, that I am not a professional lecturer, simply a plain, plodding man, but one who loves his work and believes in it—believes it is one of the most interesting, most inviting fields in the whole realm of nature today, and therefore, should I seem to speak in exaggerated terms tonight, I plead in justification the old French proverb: “When we speak of things, if we speak not with the partiality of love, what we say is not worth repeating.”

As you are aware, of course, the topic for consideration is “The United States Weather Bureau and Its Work”—a large subject, I am sure you will admit, for a short discussion. And so my embarrassment tonight arises not so much from a lack of something to say as from just what I should say in the limited time at my disposal, out of the many interesting things that might be said. To some of you, no doubt, much of what I shall say will seem so very elementary as to be uninteresting and unprofitable; to such I wish to apologize and make my peace now.

Before coming more directly to the topic of the evening, I wish to invite your attention briefly to a few preliminary considerations that it will be helpful to have fresh and clear in our minds. In the first place, consider with me the field with which we, as meteorologists, are concerned and in which our work lies. I hardly need to remind you that we live at the bottom of a great aerial sea or ocean, to the surface of which we are unable to rise. As we call the solid earth about us the geosphere, the world of water, the hydrosphere, we call this great ocean of air the atmosphere. Now it is with this last mentioned division, the atmosphere, that the meteorologist is concerned. Nothing could be more intimate than the relation existing between the atmosphere and all forms of life upon the earth; we live beneath it

and are penetrated by it; without it the earth would be inert and arid, silent and lifeless; it makes its way as a life-giving fluid into our lungs and gives an impulse to the frail existence of the new-born babe; its waves wash the mountains and the valley; it imparts verdure to the fertile fields, nourishing at once the giant oak and the tiny flower; it adorns with an azure vault the planet on which we live, love and hope, and makes for us an abode in the midst of which we sometimes act as if we were the sole tenants of the Infinite, the masters of the universe; it illuminates this vault with the soft glitter of the twilight, with the waving splendors of the aurora, with the quivering lightning; at one moment it inundates us with a flood of warmth and light, at another it causes the rain to descend in torrents on a thirsty land; it is the liquid channel by which the sweet perfumes descend from the hills; it is the vehicle of sound which permits human beings to communicate one with another, and so becomes the first bond of society; not only is the atmosphere the inexhaustible source whence every thing that lives draws breath, but it is the great reservoir into which every thing that dies pours its last breath; life and death are alike in the air we breathe; the atom of oxygen that escapes from the ancient oak makes its way into the lungs of the infant in the cradle and the last sigh of the dying man may go to nourish the brilliant petals of the flower; the breeze that caresses the blade of grass goes on its way until it becomes the tempest that uproots the forest trees and strews the shore with shipwrecks. Thus it appears that the earth's organization is such that the atmosphere is sovereign of all things and of it we may truly say, *In ea vivimus, movemur et sumus*. Where may we find lessons more practical or more suggestive, problems more interesting or more complex, manifestations more beautiful or more sublime, than in the study of the atmosphere? Surely the subject is vast and our interest in it direct and permanent, as well as real and universal. Am I not right when I say it is the duty of every man to arrive, as far as possible, at an intelligent appreciation of the physical forces and laws that preside over the changes in our weather and the seasons, and prepare for us our daily bread?

Now the science that has for its definite aim and purpose the study and investigation of this wonderful region is known as meteorology. Meteorology as a science is young, in fact one of the youngest, but as a branch of human knowledge it is as old, perhaps, as the human family; indeed, it had its beginning with the origin of human civilization. Primitive man lived principally as a hunter or an agriculturist, and, therefore, mostly in the open air. Consequently he was more dependent upon weather conditions and changes than we are today and so was under the necessity of watching these, not so much for the purpose of studying the atmosphere and discovering the laws that govern it—for he knew nothing of the "laws of nature", nothing about physical force, nothing about the necessary regularity of things, nothing about the relation of cause and effect—but he did so to derive immediate advantage to himself, to protect himself against the weather, to foresee the best conditions for his undertakings, or to

find the most favorable climatic conditions for his fields. And so, in the course of time, there grew up what we sometimes call a system of weather folklore or weather proverbs which "constitute the debris, or alluvium, brought down by the stream of tradition from the highlands of ancient mythology, and even in this day of our boasted intellectual emancipation acts as a serious handicap to the study of meteorology."

Physical science, as I have just intimated, is a very late acquisition of the human mind, and yet we are so thoroughly imbued with it as to be almost incapable of appreciating or understanding the thoughts of our ancestors. They personified everything: moon, cloud, rain, lightning, earthquake, thunderstorm. To them the moon was not a lifeless ball of clods and stone; it was the horned huntress Artemis coursing through the upper ether or bathing herself in the clear lake; the clouds were not bodies of vaporized water, they were cows with swelling udders driven to their milking by Hermes, the summer wind; or they were great sheep with moist fleeces, slain by the unerring arrows of Bellerophon, the sun; or again, they were swan maidens flitting across the firmament. And so I might go on to the limit of my time discussing these so-called weather proverbs and myths, but I must come directly to my topic—the United States Weather Bureau and Its Work.

Just here it may be helpful to refer briefly to the organic act of 1890, establishing and reorganizing the U. S. Weather Bureau, especially that portion of the act defining the functions of the Bureau as contemplated by Congress. The law says: "The Chief of the Weather Bureau shall have charge (1) of forecasting the weather";—and I may say that it is through this function, perhaps, the Weather Bureau is best known to the public, in fact there are some who think this is the only purpose of the bureau; (2) "the issue of storm warnings"; (3) "the display of weather and flood signals for the benefit of agriculture, commerce and navigation"; (4) "the gaging and reporting of rivers"; (5) "the maintenance and operation of seacoast telegraph lines and the collection and transmission of marine intelligence for the benefit of commerce and navigation";—and I may here point out the fact that this work has developed into large proportions and will doubtless continue to grow by the invention and development of wireless telegraphy; (6) "the reporting of temperature and rainfall conditions for the cotton interests"; (7) "the display of frost, cold-wave, and other signals"; (8) "the distribution of meteorological information in the interest of agriculture and commerce, and the taking of such meteorological observations as may be necessary to establish and record the climatic conditions of the United States, or are essential for the proper execution of the foregoing duties." Thus, you see the scope of the bureau, originally intended for the benefit of navigation alone, has been broadened so as to include navigation, agriculture and commerce, and its work is clearly defined. Just how well the bureau is discharging these various functions is not, of course, for me to say. It is only right, to be sure, that the people who are paying something like one and one-half million dollars annually to



FIG. 1

support the bureau should desire to know whether or not the bureau is making good, and it is only fair to the bureau that its work should be carefully and fully known before it is condemned. And so my purpose tonight is not to apologize for our shortcomings—we make mistakes, have made many, and serious ones, and will continue to make them—but rest our case on the good work we do, and to this end we court the fullest investigation.

To carry on the work of the bureau requires the services of about 600 employes outside of Washington and about 200 at the central office in Washington. In addition to these 800 or more regularly commissioned employes, the bureau enjoys the patriotic services of several thousand co-operative observers, on land and on sea, who are doing very valuable work in the collection of meteorological data and receive for their pay only such publications of the bureau as may be available for distribution. And so, altogether, there are between five and ten thousand people connected with the United States Weather Bureau, all trying as best they can to carry out the work as outlined by Congress. It may be interesting to know that the bureau now owns and maintains quite a large number of buildings, the principal ones, of course, being located at Washington, D. C., several at Mt. Weather, in Virginia, and quite a few scattered over the country. We have in operation about 200 regular stations from which reports are telegraphed to the central office twice each day, at 8 a. m., and 8 p. m., seventy-fifth meridian time. The work at the individual station is, no doubt, more or less familiar to you, or will become so, I hope, if not from this lecture then from a personal visit to the local office, where you will be quite welcome.

There is one station, however, about which I would like to say just a word before coming to the illustrated portion of this lecture, and that is the station at Mt. Weather, Va. This station was authorized and established by Congress at the earnest solicitation of Prof. Willis L. Moore, Chief of the Weather Bureau, for the purposes of original research work in the investigation of general atmospheric problems, such as solar radiation, solar physics, magnetism, etc., and for the study of conditions existing in the upper air. A number of buildings have been fitted up with the necessary instrumental equipment for carrying on real research work in upper-air studies especially. For this purpose, kites and balloons with self-recording instruments attached are sent up daily to a height of about two miles and it is expected, by thus increasing our knowledge of the upper-air, to bring about a decided improvement in the daily weather forecasts. Newly appointed assistant observers are given instruction in station duties at the Mt. Weather observatory.

“Honor to whom honor is due”, gentlemen. Surely, there can be no impropriety if, at this point, I pay a word of tribute to my worthy chief, Professor Willis L. Moore, to whom great credit is due for the commanding position now occupied by the United States Weather Bureau among the meteorological ser-

vices of the world, for, like Abou Ben Adhem, its name "leads all the rest". Fortunately for the Bureau, President Cleveland put Professor Moore at its head soon after its reorganization, and under his management it has attained to its present large proportions and high degree of efficiency. Professor Moore is recognized as one of the leading meteorologists of the world as well as a scientist of marked ability, and, what is of equal if not greater importance to the Bureau, he has shown matchless executive abilities that have enabled him to do what few men can do, namely, successfully steer a scientific bureau through all political waters for a period of 20 years or more. And so I think it both safe and fair to say that the present head of the Weather Bureau deserves a high place in the esteem of his



FIG. 2

fellow countrymen for what he has done in the efficient development of one of the greatest bureaus in our government and through it the saving of human life and property.

Coming now to the illustrated portion of the lecture, it is my purpose to show you by means of the slides a few of our buildings, some of our instruments, how the observations are transmitted, translated and tabulated, how the weather map is made, how forecasts and warnings are disseminated; in short, indicating briefly how we do our work along the various lines, such as the river and flood service, the cotton region service, corn and wheat service, etc., closing with a few slides of a miscellaneous character. Fortunately the slides speak for themselves and, therefore, little

explanation will be required, thus enabling me to show you quite a number in the little time remaining.*

The structure shown in the picture before you (Fig. 1) is quite familiar to you all, I am sure, since one has for some years occupied a prominent place on the public square of this city. This, as you know, of course, is called a "kiosk". The name is of European origin, being commonly employed in foreign coun-



FIG. 3

tries for street shelters and bulletin boards and for similar purposes, and was selected for this structure because short and expressive. The design, however, is strictly American. The

*(For reasons, it is not practicable to reproduce in this connection all the slides shown by Mr. Alexander, but we have selected a sufficient number perhaps to give some idea of the character of this portion of his lecture.—Ed.)

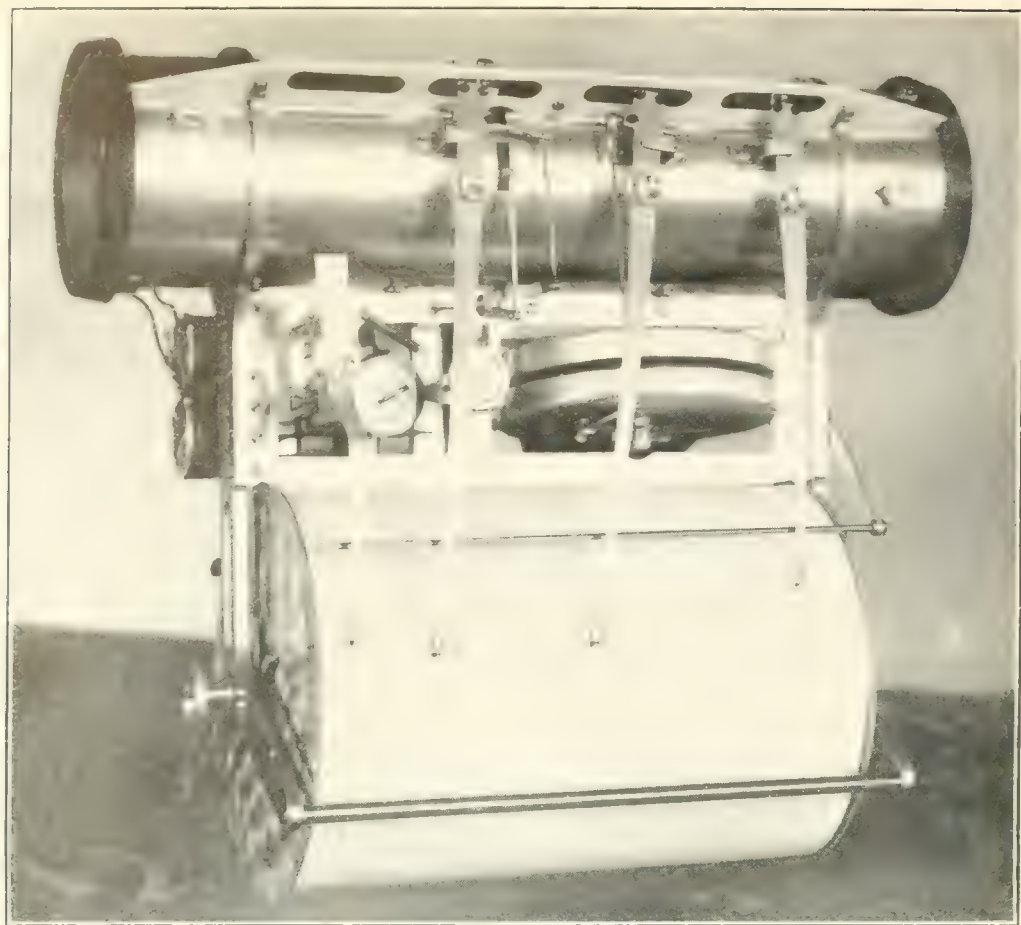


FIG. 4



FIG. 5

kiosk is a four-sided structure, one of which is used for the exposure of a fairly complete set of instruments, consisting of thermometers (current, maximum and minimum), hygrometer, thermograph and raingage; the other three sides being used for the display of weather maps or charts or such other publications as may seem to be of general interest. The demand for such a service grew out of the fact that in the large cities the local offices of the Weather Bureau are necessarily located in the tallest buildings and the instruments are exposed on the roofs of same, making them practically inaccessible to the public. Not only so, but there seemed to be a need for a reliable record of the street weather conditions in which the great mass of the people live and move and that this record should be easily accessible to the public. Hence the "kiosk".

This slide (Fig. 2) takes us to Mt. Weather, Va., and shows the observer in the act of sending up a "captive balloon". This balloon will carry up with it a meteorograph that will bring back an automatic record of the various meteorological conditions met with on the trip. This record usually shows the temperature, pressure and humidity of the air and the velocity of the wind. It is interesting to note that the Mt. Weather station holds the world's record for elevation, having secured records for a height of 18 or 19 miles. Had I the time to point out some of the very remarkable things that these great ascensions have revealed, I am sure you would be more than interested, but I must hasten. The building shown in the background is the principal one of the Mt. Weather group.

Our next slide (Fig. 3.) is also a Mt. Weather scene and shows the observers in the act of launching a kite on an aerial exploring tour of some two miles or more, also carrying with it the meteorograph, which may be seen attached within and near the middle of the kite. These kites are made at the station and are very reliable.

I wish in our next slide (Fig. 4) to show you a near view of the essential parts as far as possible of the wonderful little meteorograph that accompanies these balloons and kites in the long upward flights and brings back to us the strange story of the journey. In the main this instrument is the product of our own Instrument Division, of which Prof. Marvin is chief and whose name it bears.

This slide (Fig. 5) shows us a magnificent fog scene. The observer is standing on the hill or mountain-side looking out over a fog-filled valley, with a remarkable fog billow rising up prominently in the foreground. No one can adequately describe the wonderful play of light and shadow effects on a scene of this kind!

The instrument shown in the picture before you (Fig. 6) is perhaps unsurpassed in interest and service performed by any other meteorological instrument. It is known as the "Triple Register", should be called the quadruple register perhaps, since it gives us four distinct records, namely: wind direction,

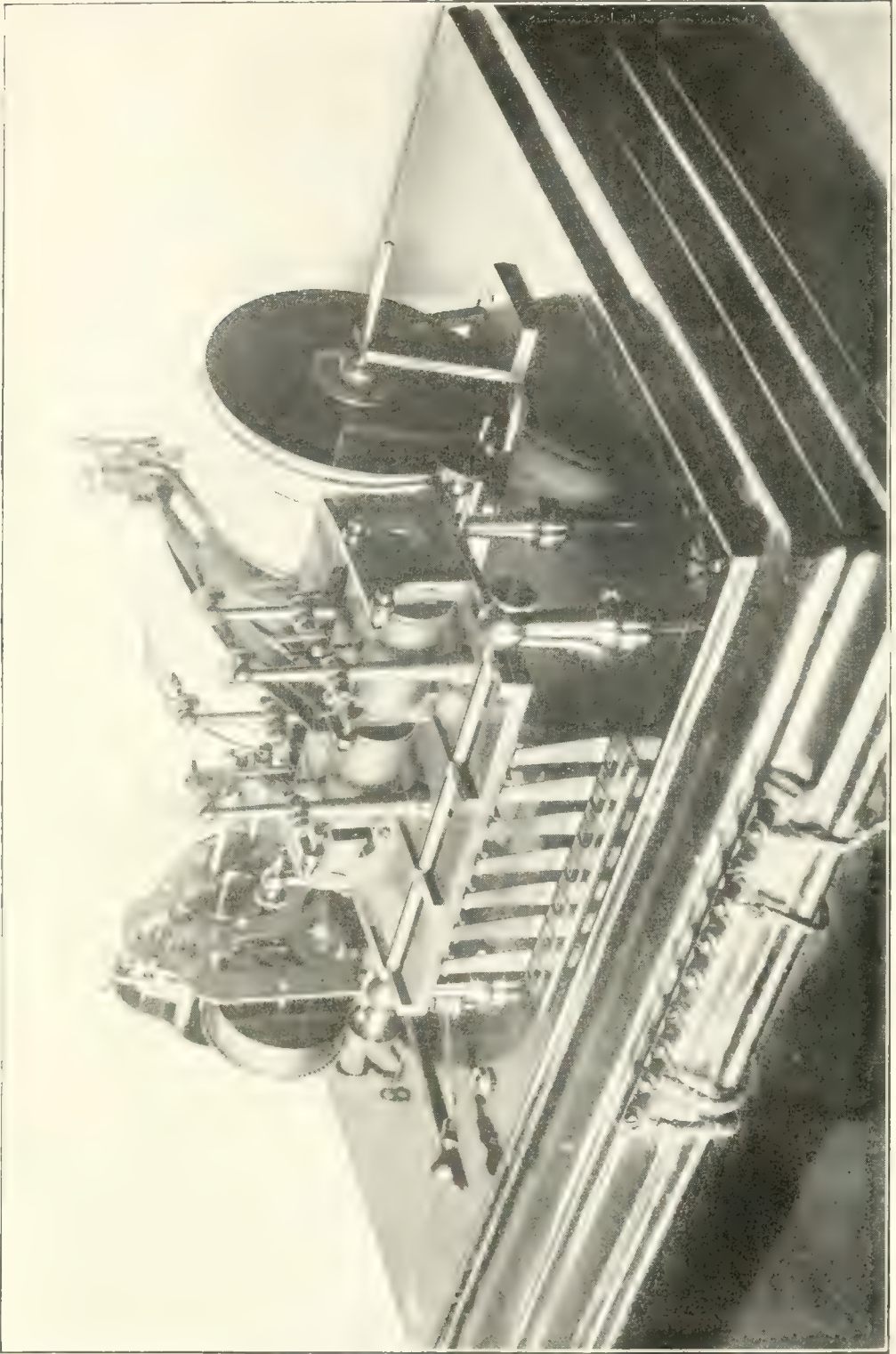


FIG. 6

wind velocity, sunshine and rainfall. It records the direction of the wind at the end of each minute, for eight directions; records automatically every mile of wind that passes the station; the number of hours and minutes the sun shines and the amount of rainfall to the hundredth of an inch. That is, every one-hundredth of an inch of rain that falls in the gage is recorded, thus

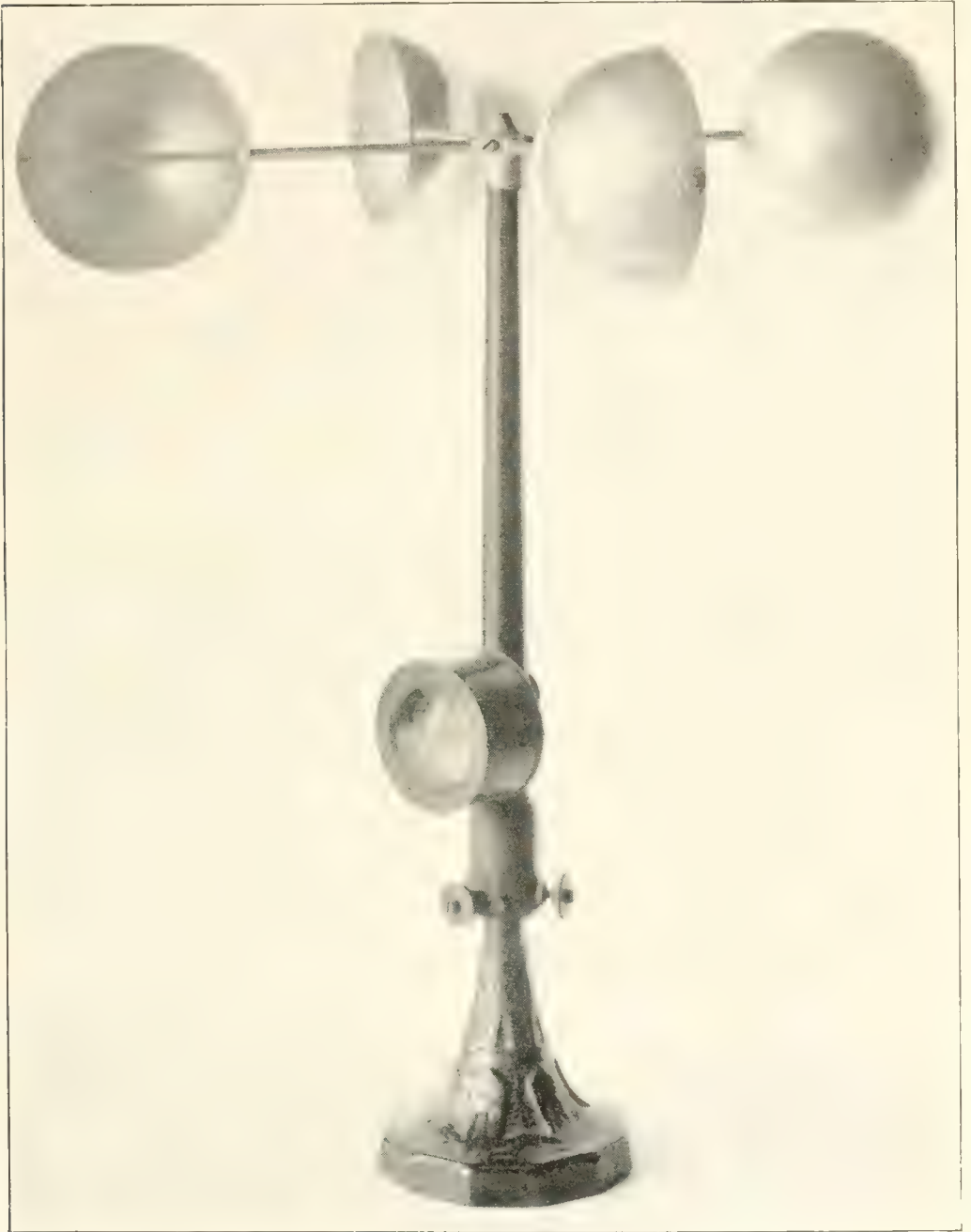


FIG. 7

showing not only when and how much rain falls, but the rate at which it is falling. This instrument is, of course, located in the office and is electrically connected with the wind vane, anemometer, sunshine recorder and raingage, which are usually exposed on the roof of the office building and should be as high as or higher than the surrounding buildings.

A nearer view is shown in this slide (Fig. 7) of the anemom-

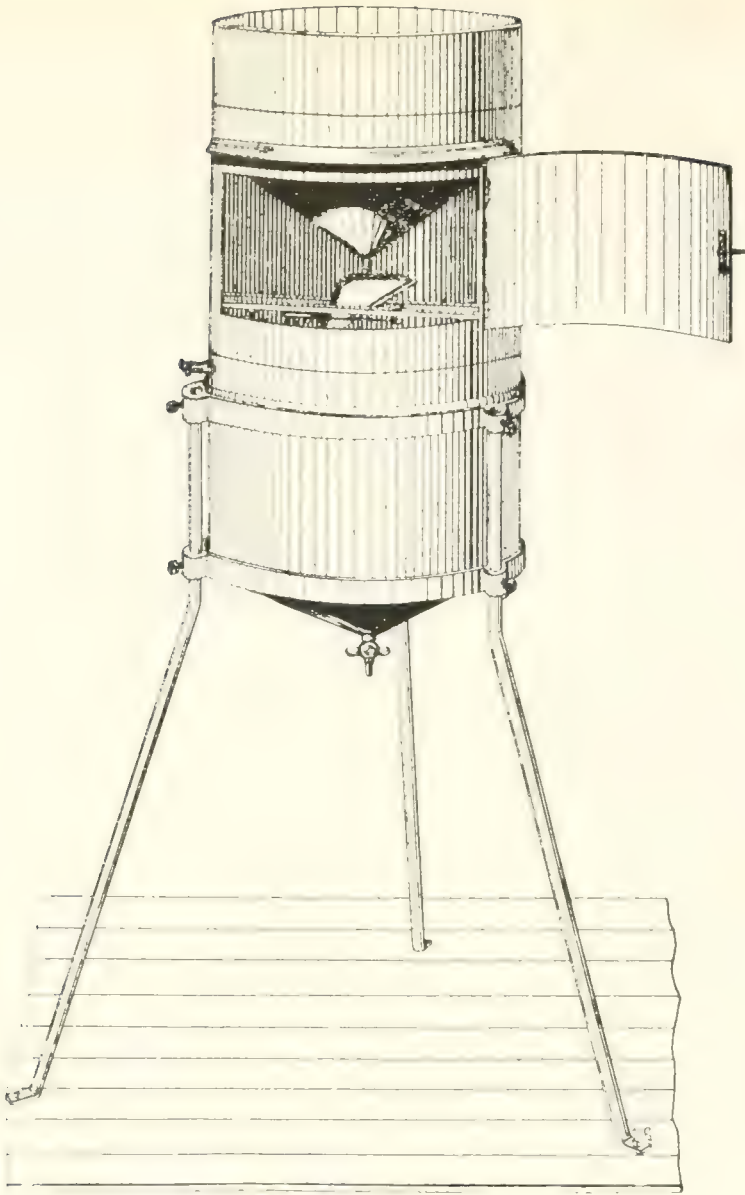


FIG. 8-A

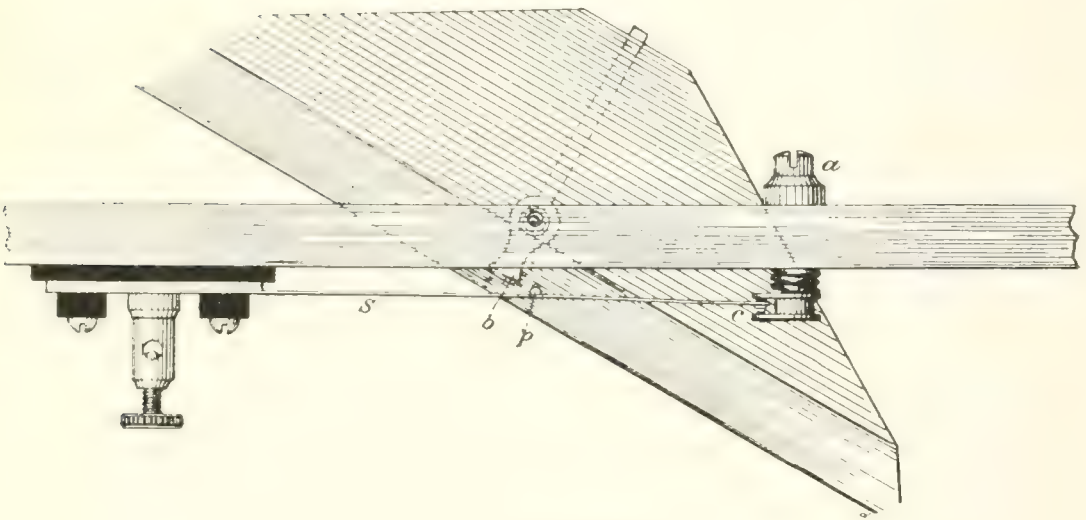


FIG. 8-B

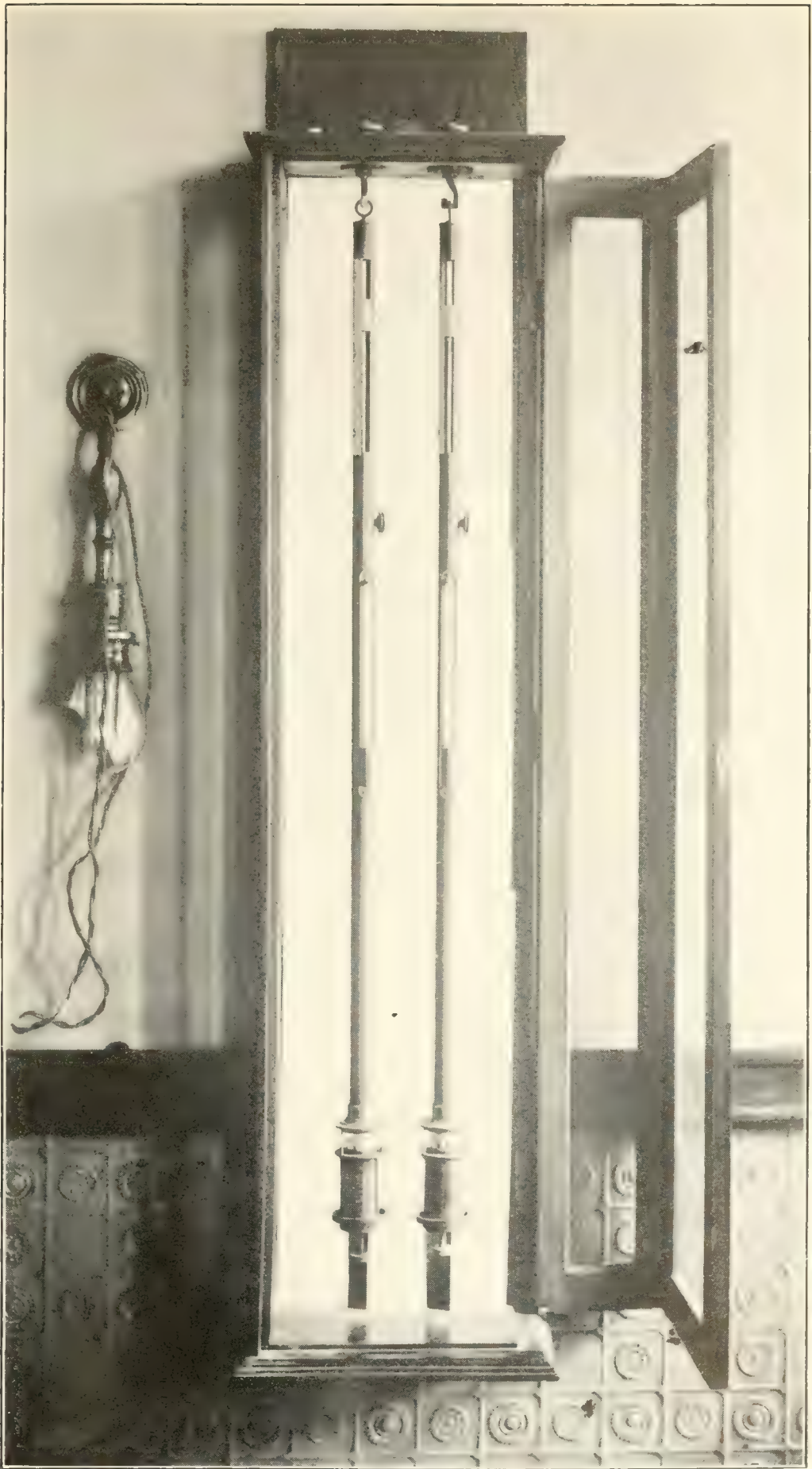


FIG. 9

eter, or the instrument used in measuring wind velocity. As you see, this instrument consists essentially of four aluminum cups, delicately poised so as to be driven by the wind, the cups moving, as shown by numerous experiments, about one-third as fast as the wind. Hence when the cup has made a sufficient number of revolutions to amount to one-third of a mile the wind has made a complete mile; therefore, the anemometer is so designed as to record at the end of the required number of turns of the cups. While the record made by this instrument for very high and possibly for very low velocities is not absolutely reliable, yet for all ordinary velocities it is entirely so, and is the best means yet devised for recording wind movement.

The next view (Figs. 8) will enable you to see something of the mechanism and action of the self-recording raingage. Through the open door of the gage you can see how the rain that falls into the receiver runs through a small funnel and is caught in a little "tipping bucket" placed just below the funnel. This little bucket is divided into two chambers and the rain is caught first in one and then in the other, the weight of the water tipping the bucket. The bucket is so balanced that when one-hundredth of an inch falls into either chamber the weight of the water tips the bucket. Each tip of the bucket is recorded electrically on the Triple Register below, as has been explained.

I now ask your attention for a moment to the instruments by which the pressure or weight of the air is measured. In the picture before you (Fig. 9) is shown the ordinary mercurial barometer. This is essentially a column of mercury in a glass tube, the upper end of which is sealed, and the lower, open end plunged into a cup of mercury so that the column of mercury is sustained solely by the pressure of the air on the surface of the mercury in the cup, the result being, of course, that the weight or pressure of the air exactly balances the weight of the column and any change in the weight of the air is shown by a corresponding change in the height of the column. The other parts shown are, in the main, simply devices for measuring the exact length of the mercurial column, which under ordinary conditions at sea level is about 30 inches, and weighs between 14 and 15 pounds. As a rule the importance of these pressure changes is not appreciated by the public, but to the meteorologist and the weather forecaster they are exceedingly important, being, in fact, the principal basis upon which he makes his forecast, the weather and weather changes at any given locality depending almost entirely upon pressure changes. The barometer was for a long time—and in some sections even today—called the "weather glass". I may add, as a matter of historical interest, that its invention is generally credited to Torricelli, in about the year 1643 (at least he discovered the principle upon which it is based), and was the first great step forward in meteorological work, as it then became possible to weigh the atmosphere about us.

The next slide (Fig. 10) shows an open barograph—an instrument also for measuring the pressure of the air, but with the additional advantage that it gives us an automatic record of this

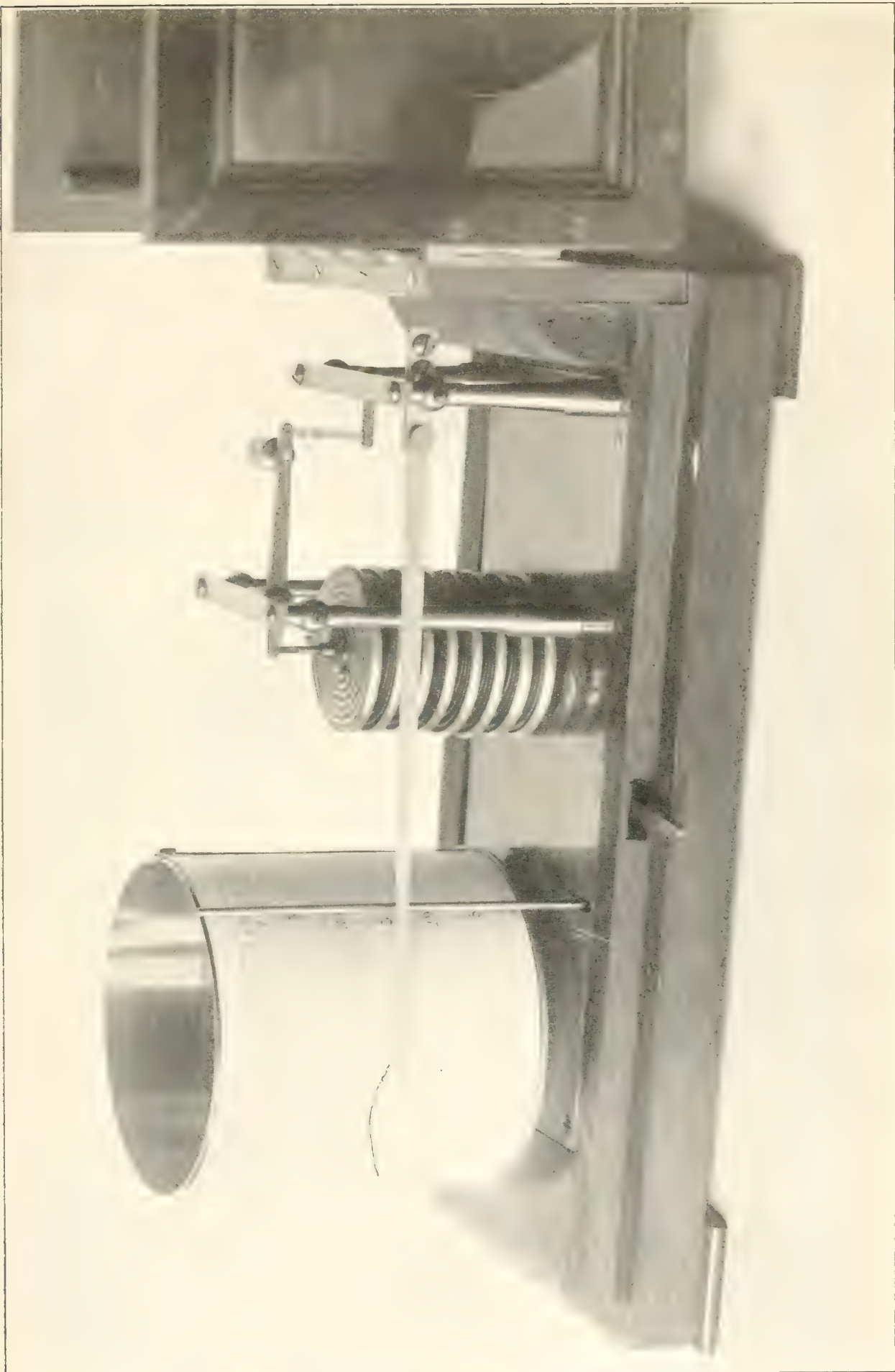


FIG. 10
335

pressure, thus enabling us to tell at a glance whether the pressure is increasing or decreasing. The upward tendency of the trace shown on the cylinder indicates an increasing pressure which at the time the photograph was made was about 29.60 inches at the place where the instrument was located.

I told you a moment ago that in the meteorological field are to be found not only practical problems, but things of wondrous beauty, and I think only "a peek" is sufficient to convince you of the correctness of my claim. I therefore ask you to look just for a moment at this familiar cloud scene (Fig. 11); these are the storm signals of the sky and often pass before



FIG. 11

you in panoramic view, presenting endless variety of form and color. One may not only see the beautiful in these scenes, but even the tragic, as when these clouds are torn to fragments by the terrific winds that often assail them; they may smile upon us, or they may alarm us with their angry, forbidding, yes, threatening appearances. They are often full of blessings—sometimes of destruction. Sometimes they shower upon us in inconceivable numbers beautiful specimens of nature's handiwork, like that shown in the next slide (Figs. 12). No one can tell, for no one knows, the infinite beauty and variety displayed in these visitors from cloud-land; if we did know I am sure we would tread with reverent feelings upon the crystals at our feet. I want

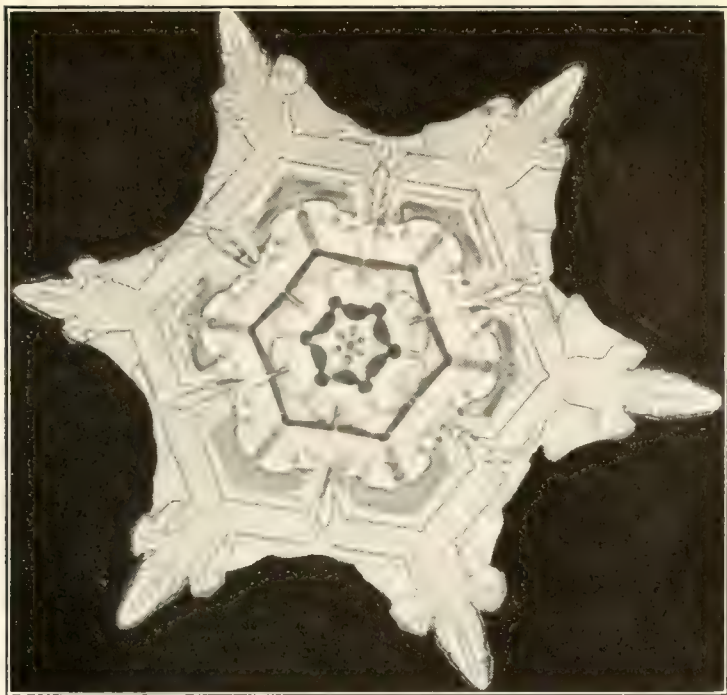


FIG. 12-A

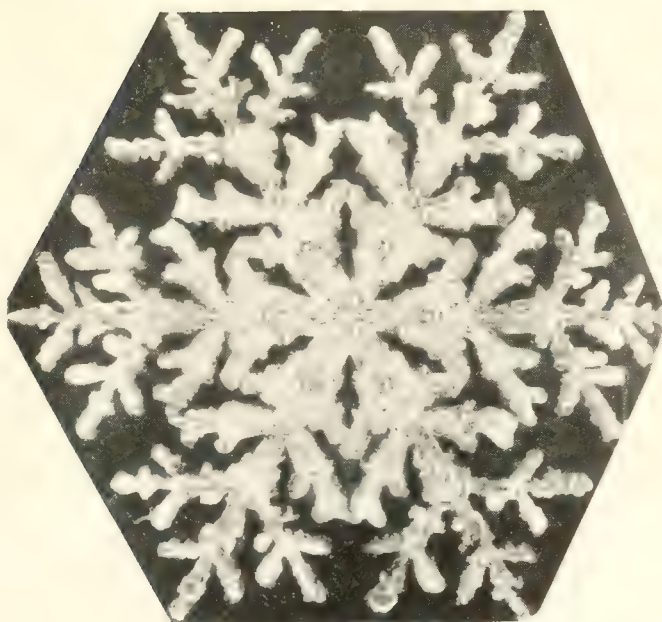


FIG. 12-B

just here to pay a tribute to my friend, Mr. Wilson A. Bentley, of Jericho, Vt., who sent me the specimen now before you and who has led the world in photographing the snowflake. He now has 2,000 or more different varieties.

Oct. 8, 1912.

(Stenographically reported.)

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The Superior Avenue Viaduct, Cleveland

BY B. F. MORSE.

During February, 1909, the author of this article wrote a brief history of the Superior Avenue viaduct, from which were omitted some matters that will now be added.

In my first article, I stated that for the last year or two there had been considerable talk about the safety of the two Cleveland viaducts. It occurred to the writer, who took charge of the Superior Street Viaduct in April, 1875, as City Civil Engineer, that a brief historical sketch of its inception, construction and cost, would at this time be of interest to many people in Cleveland.

Back in the early seventies and previously, a large portion of the travel between the west and east sides of the river was via Detroit Avenue hill, Center Street N. W., Columbus and South Water or West 9th Street hill, and Superior Avenue hill to Superior Avenue W.

At the foot of West 9th hill and part way down the Superior Avenue hill, are located the two tracks of the C., C., C. & I. Railroad, now called the Big Four. The frequent passage of trains caused a great deal of delay to street traffic, and the necessity for some relief became very pressing. It was at first proposed to sink the railroad tracks and raise the streets sufficiently to allow all street traffic to pass over them. This project was under consideration for some time, but as the city increased in population it became evident that this route would not answer for all time. In the meantime, two high level routes had been under consideration. One was Superior Avenue and Franklin Avenue, and the other Superior Avenue and Detroit Avenue. The latter was finally adopted and the sinking of the railroad tracks abandoned. The route was established west of the river in 1873, and options for the right of way 80 feet in width were taken, except at the river, where additional land had to be purchased covered by the swing of draw or swing bridge, and the right to cross the two tracks of the Erie Railroad in the deep cut west of Center Avenue N. W. While this was being done, some of the property owners fronting on the river above the proposed draw, claiming that it would be an obstruction to navigation and a damage to their property, procured a temporary injunction from an Akron judge, which, after some months delay, was dissolved, and most of the right of way settled for.

The viaduct began with a lawsuit and ended with one, which will be referred to later.

The Superior Avenue Viaduct, as first designed, except across

the river, was by a series of stone arches with two river piers. The reason why the stone arches east of the river were not built will be given further on. The viaduct west of the river, as first planned, was to have eight segmental arches of 83 feet span, and one of $97\frac{1}{2}$ feet, all having a rise of 21 feet, and a brick arch culvert spanning the two tracks of the Erie Railroad. The width was to be 50 feet from out to out. The two river piers, the arches, piling, grading, filling, etc., west of the river, were put under contract during the winter of 1874 and 1875, or previous to April, 1875. The floor of the draw was to be 16 feet lower than the floor of the draw as built, with a grade of 1 per cent rise over the arches west, and about 4 per cent rise east of the river.

The location of the viaduct east of the river on Superior Avenue hill had not been definitely settled. Some wanted it on the north side, and others on the south side. It was finally located at the latter place and at first entirely out of the street, for fear that the property owners would prevent the occupying of part of the street on the hill. This would have made an angle in the part on Superior Avenue hill. This part of the avenue was 62 feet wide at the west line of 9th Street and 130 feet wide at the river. It was finally decided to make the east end straight, covering enough of the hill to make it of uniform width from 9th Street to the river, and appropriate sufficient land and buildings to straighten the eastern end and fight it out in the courts as to encroachments on the street. Some suits were commenced by property owners on the north side of the hill, but they did not amount to much.

The viaduct as first planned, 50 feet in width, was estimated to cost \$1,100,000. Before or about the time the contractor commenced work in March, 1875, it was decided to widen the viaduct to 64 feet. The contractor commenced to drive piling before it was widened. The first stone was laid May 20, 1875. The work progressed fairly well during the working season.

Then, during the winter of 1875 and 1876, it was decided to raise the grade of the roadway of the viaduct 16 feet at the draw. The eight segmental arches of 83 feet span and the $97\frac{1}{2}$ -foot arch all to have a rise of $33\frac{1}{2}$ feet, the grade over the arches west to be $\frac{1}{2}$ of 1 per cent, and $\frac{2}{3}$ of 1 per cent east of the river.

The first contract west of the river before the bridge was widened and raised called for a brick arch or culvert over the two tracks of the Erie Railroad in the deep cut, but the city was finally compelled to build an arch to span four tracks. This, the widening and raising of the grade and extra piling, etc., and right of way, added very materially to its cost. There was some talk of making it a high level viaduct without a draw at the time it was raised 16 feet at the river. Probably then one-half of the boats were large three-masted sailing vessels with top masts reaching to a height above the water of from 100 to 125 feet. For this reason the viaduct was built with a draw.

The masonry west of the river, if it had been possible to have founded it on rock or shale, would have lasted indefinitely, without settling. Borings had been made and no rock or shale was reached within reasonable distance, and it was finally decided to drive piles, and it required an immense number of them. If all the piles used under the viaduct were laid end to end they would cover a distance of 40 miles. The nature of the materials on the flats on the line of the viaduct was such that the whole width of the right of way had to be used and more was needed in places to develop the requisite foundation to carry the superstructure. The piles under the piers were cut off about four feet below the water in the river and the earth excavated one foot deep around the heads of the piles, the spaces filled in solid with concrete, and leveled off even with the tops of the piles. Oak timbers, 10 x 12 inches in section, were then laid on top of the piles and concrete, spaced about one foot apart, and the spaces filled with concrete. Then a grillage of 10 x 12-inch timbers was laid close together crosswise of the lower ones, and on these grillages the stone piers and abutments were built.

For the center pier of the draw span on the west side of the river a large hole was dredged out sufficient for the piers and the timber crib around it. A test pile was driven and it was found necessary to procure piles 65 feet in length. After the piles were driven and cut off the same as under the other piers, the timber crib was built up around the piles, then the space inside the crib and around the piles was filled with concrete spouted in, tamped down and leveled off even with the tops of the piles; the whole pier inside the crib was then covered with a double grillage on which the masonry was built. The piles under the pier in the river on the east side were cut off 16 feet below the surface of the water, and a watertight timber caisson was built and launched and the masonry started in it, and when partly submerged was floated and sunk on the piles in its proper place, and then the pier was completed. The outside of this pier was fine pick dressed, instead of being left rock faced, like the rest of the work, for the reason that if a boat should run into it or hit it, it would be less liable to damage the boat or the pier. There are no piles under the arch over the Erie Railroad tracks, nor under any of the piers on Superior Avenue hill.

On the lower side of the piers first east of the river, a row was driven to prevent sliding toward the river. The piles driven under the piers of the arches varied in length from 30 to 45 and 65 feet, and were generally driven from two to three feet apart between the centers and in some places less. The materials on the river flats is composed of river and sand silt and mud for a considerable depth mixed in different proportions even in the same pit or foundation. This lack of uniformity made it frequently necessary to change the lengths of the piles and their distances apart to get the required sustaining power to carry the superstructure. The pits west of Center Avenue were entirely in blue clay where the piles went down under the last blow of the driver on an average of five inches, while those on the

flats went down on an average, three inches. The weight on some of the piles exceeds 20 tons, and the weight per square foot of surface covered by the footing courses in some of the foundations exceeds five tons. Test levels were taken on the footing courses of all the piers and abutments before and after they were built up to the springing of the arches, and at intervals of from six to twelve months before the viaduct was completed, the roadway paved and the full and permanent load was placed on the foundations and yearly thereafter until 1882. From the time the viaduct was completed for a period of four years, only about $\frac{1}{2}$ to $\frac{5}{8}$ of an inch settlement had taken place, as shown by the test levels, except at the west end of the draw at pier No. 8. All these piers and abutments settled while this part of the viaduct was being built on an average of three inches, some more, some less.

Some years ago the city let a contract to open or cut a channel west of the center pier of the draw for boats to pass through as originally planned. It progressed so far that pier No. 8 settled several inches. The work stopped and no settlement has taken place since.

The old Valley Railroad draw just above the viaduct was also located to allow boats to pass west of the two draws, but the rolling lift bridge that the B. & O. Railroad built with permission of a previous city administration, will prevent this west side channel from ever being opened.* All the arches show cracks running longitudinally of the viaduct near the centers, varying from $\frac{1}{2}$ to $1\frac{1}{2}$ inches open at the keys or crown of the arches, and disappearing near the springing lines. These cracks were caused by the unequal settlement of the foundations, but do not render that part of the viaduct unsafe. A very heavy batter had to be given to all of the piers and abutments in order to spread the foundations sufficiently to carry the superstructure.

In the viaduct as built there are eight arches 83 feet span and two $97\frac{1}{2}$ feet span. It was planned so as not to place any of the piers in the streets. But for that reason it would have been better to have made the arches of less span, say about 60 feet and they would have been less liable to settlement.

The fixed spans east of the river and the draw, except the 150 feet of continuous plate girder, were built in what, in 1876, was called the Linville or Pratt double-intersection type, and all parts proportioned to carry a live load of 100 lbs. per square foot of roadway, or 6,400 lbs. per lineal foot of bridge, with a factor of safety of five, which was then considered ample for city bridges. Since then most of the bridges have been built on the single intersection type. For one reason, they can be built at less cost. The first street railroad tracks laid on the bridge were planned for four-wheel horse cars, and were too light for the heavy eight-wheeled suburban cars that run

*The erection of the B. & O. Railway bridge was in accordance with federal authority given after the usual public hearing in the United States Engineer's office. Then, as now, it was proposed to abolish the present draw span of the Superior viaduct and to remove the center pier, which, it was decided, would leave an ample waterway, fully as useful as two smaller channels, one on each side of the center pier.—Ed.

over it now. Several years ago the rails first laid and the supports under them were taken up and replaced with new and heavier ones and designed to be made safe for the heavy cars used now. All the tracks on the viaduct ought to be relaid with new and improved grooved rails, as I said in my article written in February, 1909.

The whole viaduct has been badly neglected for the past 10 or 15 years, caused by frequent changes in the city government, and new men being put in charge of the viaduct without much if any experience. Ignorance has produced waste and may cause disaster. For instance, on the fifth day of July, 1910, a car going east on the draw, carrying 80 passengers, left the rails near the east end and came very near plunging into the river, 70 feet below. If there had been grooved rails and the ends of the draw had been kept in repair, this accident would not have occurred. The draw has since been thoroughly overhauled and put in good working condition.

The draw span is 332 feet long, each arm being 166 feet in length from the center. In very cold weather it contracts so as to leave an opening of three or more inches, and the rapid movement of the heavy cars on and off the ends of the draw and the bad order in which the ends of the rails and the frogs at the ends of the draw have been allowed to be used for weeks and months (these openings between the ends of the rails have been in some cases as much as six inches) and the wedges under the ends of the draw not being in good working order in recent years, have no doubt caused an unusual and extraordinary strain on the draw span. The draw is of extra heavy construction, for the reason that there could be no protection piling under its ends when open. It has been widened four feet, two feet on each side, in recent years, and has withstood an unusually hard usage for a long time, and has not been laid up on one entire day since it was built. With proper repairs to car tracks at the ends of the draw and the end wedges, and the turn table under the draw, and with careful usage such as any steam railroad would give to avoid accident and consequent damages, the eastern end, including the draw, can be made to last many years longer.

The opening of the draw on an average of 3,240 times a year, 270 times per month, or 19 times per day, causes some delay. When the draw is in good working order it can be opened, a boat passed through and closed again, ready for traffic, in from four to six minutes, or an average of five minutes, or a loss of 95 minutes in 24 hours. It has been swung or opened for the passage of some kind of a craft probably not less than 100,000 times during the 33 years it has been in use, without the stoppage of street traffic one day, which is quite remarkable considering its location on a sharp bend of the river.

During the year 1879, 3,572 craft passed through and under the draw and it was opened 3,308 times. During the year 1880, 3,928 passed through and under it, and it was opened 3,374 times. That was 30 and 31 years ago.

The radii of some of the sharpest curves on the center line of the Cuyahoga river at the time the viaduct was opened for use, in 1878, were as follows: On the center line under the easterly arm of the viaduct draw, 354 feet; of the curve between Seneca Street and the lower Central Way bridges, 265 feet; of the curve at the Connotton Valley R. R. bridge, 325 feet; through Jefferson Street bridge, 275 feet; just below the Valley R. R. bridge, 300 feet. In order to get the greatest possible opening for boats to pass, the pier in the river at the easterly end of the draw was set 10 feet back from the end of the draw and one panel of the fixed iron span was projected out to meet and connect with the draw. This was done so that in opening and closing the draw the end of it would not prevent boats from laying at the river dock just above the viaduct.

From the experience gained in building the viaduct west of the river the writer recommended that the east side be built of iron. If built of masonry arches, in order to get safe foundations a wider right of way would have to be purchased, and piles driven and cut off below water in the river for part of the way up Superior Avenue hill, and would have damaged property much more than the iron structure as built, and its cost would have been approximately \$300,000.00 more. City bonds at that time bore 6 per cent and the interest on the above sum would in one year amount to \$18,000.00, and in 10 years \$180,000.00, a sum sufficient to rebuild every 10 years, or less, the entire structure as now built east of the river, including the draw span, all of which cost about \$162,000.00. This part has been in constant use over 32 years, and can be made to last many years longer with proper care.

The interest on \$300,000 at 6 per cent per year..\$18,000.00

The interest on \$162,000 at 6 per cent per year.. 9,720.00

Saving per year of interest.....\$ 8,280.00
and for 32 years, \$264,960.00. Even at an average of 5 per cent for 32 years, this saving in interest would amount to \$220,800.00.

The total cost of the masonry, etc., west of the river, including the two river piers was..... \$1,378,655.37

The cost of the iron draw bridge and the fixed spans east of the river, including planking, etc., was.....\$129,852.39

The cost of the masonry east of the river was..... 30,523.09

Total cost of the viaduct east of the river, including the draw, was..... 160,375.48

The machinery for the draw, iron railings, stairs, sidewalks, etc..... 37,890.86

Right of way, engineering, etc..... 600,000.00

Total cost when completed..... \$2,176,921.71

**This description was added in 1912.*

Amount authorized by the legislature as per estimate	\$2,200,000.00
The cost of the viaduct, exclusive of the right of way was.....	\$1,576,921.71

It was finally completed and opened for traffic, December 28th, 1878, 32 years ago last December.

After the viaduct was completed and in use, the executor of the estate of General Ensign, who was the contractor for the part west of the river, put in a claim for about \$150,000.00 for extras, most of it for backing over the arches and piers between the spandrel walls. The claim was rejected. The executor then commenced suit in the United States Court, but finally failed to establish the claim.

As to the practicability of using the masonry arches west of the river, on which to build a high level bridge, that would depend on the weight of the structure to be added. From the experience gained in putting in those foundations it would indicate that they would not carry a very heavy additional load without further settlement.

A plan has been suggested to safely increase the capacity of the old viaduct west of the river which contemplates widening it the full 80 feet right-of-way by placing the sidewalks on iron supports outside the masonry, making the roadway 62 feet between and leaving two sidewalks nine feet in width; also elevating the two street car tracks sufficiently at the river to do away with the draw span and connecting them each way with proper grades to the present tracks. The elevated part over the old viaduct to be used for street cars only.

By this plan a draw or lift bridge (not a rolling lift) of about 200 foot span would have to be used at the river for street traffic. It is quite probable that a lift draw could be built that would delay street traffic only about three or four minutes for the passage of the larger boats and the street cars would not be delayed at all. This would also give a clearance of about 63 feet, about twice what it is under the old draw, and on that account would not have to be lifted as often as the old one is opened. On this plan the spans east of the river would have to be enlarged or replaced with new ones, on account of the widening. Also by this plan no damage to the property now fronting on the viaduct would occur. It might be well to construct a narrow foot bridge alongside of the street car span over the lift bridge, with stairs on each end, so that if there should be any delay on account of the passage of boats, people on foot would not be delayed.

An elevated road for cars might be constructed from West 25th Street over the viaduct and through to Superior Avenue to East 9th Street, thence to Euclid Avenue and on eastward.

Society Notes

MINUTES OF MEETINGS

November 12th, 1912.—Regular meeting called to order by President Himes at 8 o'clock p. m. Present, about 110 members and guests.

The minutes of October 8th and 22nd were read and approved.

President Himes announced the election by the Board at today's meeting of the following men to the grades of membership indicated:

Active Members.

AFFELDT, ERNEST JULIUS,
FRASER, JAMES M.,
KILROY, EDWARD A.,
NEWTON, ERNEST JAMES,
WILSON, HENRY M.

Associate Members.

GAHUSE, JOEL,
STALLEY, HARRY C.

Junior Members.

BARROW, HAROLD E.,
POPP, HARRY EUGENE.

Announcement of applications received by the Board at today's meeting was made as follows:

Active Members.

BACON, MARVIN J.,
BREOR, FRANK H.,
BROCKWAY, BYRON B.,
COOK, ALEXANDER B.,
MCKINNEY, CONRAD F.,
PHILLIPS, HARRY J.,
SIMON, ADOLPH G.,
STEVENS, ARTHUR L.,
TASHJIAN, ARMEN

Associate Members.

BLACK, GEORGE S.,
OGLEBAY, CRISPIN,
STICKLE, ROLLIN J.,
WATTS, RALPH,
WEAVER, FRANK A.

Junior Members.

KNAPP, LEONARD W.

An announcement was read of a series of talks to be given by Smoke Inspector Roberts to operating engineers, in which an invitation was extended to our members to attend these meetings as scheduled.

(See bulletin board.)

An invitation was also read to attend a meeting and entertainment at the Hollenden, under the auspices of the Metal Trades Association, on November 16th.

President Himes announced the death on October 21st, of Joshua D. Varney; also stated that a committee would be appointed in the near future to draft adequate resolutions.

The President then introduced Henry N. Ogden, professor of sanitary engineering at Cornell University, who read a paper on "Public Sanitary Control of Non-Navigable Streams", which was followed by a lively discussion.

President Himes then gave a brief resume of some of the important business recently transacted by the Executive Board.

Adjourned.

DAVID GAEHR, *Secretary.*

November 19, 1912.—Informal meeting in the rooms at 8 p. m., J. H. Herron presiding. Present, about 80 members and guests.

Mr. W. O. Henderer, president of The Osborn Engineering Company, presented a paper on "The Testing and Inspection of Structural Material", which was followed by a lively discussion.

Meeting adjourned.

G. S. BLACK, *Acting Secretary*.

November 26, 1912.—Special meeting called to order by F. C. Osborn, past president, at 8 p. m. Present, 106 members and guests.

Mr. Osborn introduced Mr. E. P. Bullard, Jr., president The National Machine Tool Builders' Association; also president The Bullard Machine Tool Company, Bridgeport, Conn., who presented a paper on "The New Era in Machine Tool Design" (illustrated).

A lively discussion followed the presentation of the paper.

Adjourned.

G. S. BLACK, *Acting Secretary*.

December 10, 1912.—Regular meeting of the society called to order by the President in the auditorium of the Electricity Building of Case School of Applied Science, at 8 p. m. Present, about 250 members and guests.

The reading of the minutes was dispensed with.

The Secretary read the names of the men elected to active membership at the Board meeting, Dec. 10th, as follows:

ARTHUR L. ANGELL,
WILLIAM L. FEWSMITH,
JOHN E. HOUSER,
ROBERT H. LEE,
WILLIAM R. MOTT,

FRANK G. PHEGLEY,
EDWARD W. P. SMITH,
FREDERICK B. WIEGAND,
TRACY B. WILLIAMS.

The Secretary then presented the following resolutions, which, upon motion, were approved and ordered spread on the minutes, and printed in the transactions, a copy of THE JOURNAL, in which they appear, to be sent to the families of Mr. Hyde and Mr. Varney.

Resolved, That in the death of our late fellow member, Gustavus A. Hyde, on the 26th day of November, 1912, this society and the profession at large has suffered a serious loss;

That we extend to his family our sincere sympathy;

That a copy of the Memoir, as printed in the Transactions, be forwarded to his family, and that this resolution be spread on the records of this society.

(See Memoir on page 276, of January, 1913, JOURNAL.)

Resolved, That in the death of our late fellow member, Joshua Davis Varney, on the 21st day of October, 1912, this society has suffered a loss and our profession a very proficient man;

That we extend to his family our sincere condolence;

That a copy of the Memoir, as printed in the Transactions, be forwarded to his family, and that this resolution be incorporated in the minutes of this meeting of our society.

(See Memoir, on page 277, of January, 1913, JOURNAL.)

President Himes then introduced Mr. N. W. Storer, Special Engineer with the Westinghouse Electric & Manufacturing Company, of East Pittsburg, Pa., who presented an illustrated paper on the "Electrification of Steam Railroads", which was followed by an interesting discussion.

Adjourned.

DAVID GAHR, *Secretary*.

December 17th, 1912.—Informal meeting called to order by Prof. Dalton Moomaw, at 7:45 p. m., in the club rooms. Present, about 120 members and guests.

Prof. Moomaw introduced Mr. A. M. Felgate, who presented a paper on "The Foundations of the High Level Bridge". A lively discussion followed the presentation of this paper.

Adjourned.

G. S. BLACK, *Acting Secretary.*

January 14th, 1913.—Regular meeting called to order by President Himes at 7:55. Present, 128 members and guests.

The minutes of the meetings of November 12th and December 10th, and the records of the meetings of November 19th and 26th and December 17th were read and approved.

The Secretary presented the following list of names of the men elected to membership at the Board meeting, January 13th:

For Active Members:—

A. L. ANGELL,	E. W. P. SMITH,
W. L. FEWSMITH,	F. B. WILGAM,
J. E. HOUSER,	T. B. WILLIAMS,
R. H. LEE,	W. R. MOTT,
F. G. PHEGLEY,	

Similarly announcement was made of the following list of names of men who have applied for membership in the society:

For Active Members:—

F. B. ALLEN,	E. S. JACKSON,
R. G. BACKUS,	Z. B. LEONARD,
W. P. BROWN,	R. S. MAYER,
D. S. COLE,	A. P. SELTZER,
H. K. FERGUSON,	M. B. SHEA,
H. E. GILMAN,	M. H. SUSSMAN,
R. D. GRANT,	H. R. TAYLOR,
W. GROTHE,	

*For Associate Members:—*A. C. BEHLEN.

*For Corresponding Members:—*C. M. OSBORN.

President Himes then introduced the speaker, Mr. James L. Stuart, Constructing Engineer of Pittsburg, Pa., who presented a paper on "Business Methods in Construction Work."

In the ensuing discussion, many questions were asked, all of which were ably answered by the speaker.

Adjourned.

DAVID GAHR, *Secretary.*

January 21st, 1913.—Informal meeting called to order by Mr. J. H. Stratton at 7:45 p. m. Present, 36 members and guests.

The chairman introduced Mr. Ward Harrison, Illuminating Engineer of the National Electric Lamp Association, who presented an illustrated paper on "The Practical Illumination of Factory Buildings".

An interesting discussion followed, which proved the presentation of this subject to be a timely one.

Adjourned.

DAVID GAHR, *Secretary.*

January 28th, 1913.—Special meeting called to order by President Himes at 7:55 p. m. Present, 65 members and guests.

Mr. Himes introduced Dr. C. H. Fulton, Professor of Mining Engineering in Case School of Applied Science, who gave an illustrated talk on "Physics of the Iron Blast Furnace in Reference to Slag Formation".

In the succeeding discussion, questions were asked and ably answered by the speaker.

Adjourned.

DAVID GAEHR, *Secretary.*

INSPECTION TRIP

By C. E. DRAYER.

A party of some 50 members of the Society and guests inspected the plant of the Brown Hoisting Machinery Company and the Kirtland Pumping Station on the afternoon of February 4th. As on other outings of the Society during the past fall and winter, favorable weather added to the pleasure of the trip.

The visitors at the "Brown Hoist" were greeted by Chief Engineer W. K. Monroe, Assistant Chief Engineer A. E. Spooner and Chief Draftsman W. L. Westcott, who directed them first through the drafting room, where about 100 men are employed, and then through the blue print room and the photographic laboratory. In the blue print room a machine was in operation, capable of printing, toning, washing and drying on a continuous roll of paper about 60 blue prints, 24 inches x 36 inches, in an hour. In the photographic laboratory, prints of machinery were being made from negatives taken by the company's photographer.

From the offices the party was conducted to the main shop building, a structure measuring inside 497 feet long and 308 feet deep, enclosing an area of three and a half acres. The casual observer, unacquainted with the circumstances surrounding its construction, yet seeing the imprint of ability and ingenuity in the design, is moved with a desire to know its history.

On December 17, 1900, the entire plant, consisting of brick and mill type buildings, was burned. Alexander E. Brown, whose name the industry bears, at once began to build a greater and better plant. In the summer of 1901, the present main shop building was begun, and was finished in the spring of 1902. Made of steel columns and trusses connected with glass and "ferroinclave", Mr. Brown's idea of a building, light, roomy and fireproof, was accomplished. He invented "ferroinclave" in an effort to find for his new shop building a fireproof construction more enduring than any then on the market. Today the shop stands as an effective testimonial to the success of this combination of iron and cement in roofs, walls and stairways.

The shop is divided into seven panels, of which 1 and 2 contain the machine department, 3 and 4 the construction department, 5 and 6 the bridge department, and 7 the plate and smith departments. To handle material and machinery there are four 20-ton and three 40-ton electric travelers designed to move along the track at a speed of 750 feet a minute. The 20-ton travelers have each two 10-ton trolleys, while the 40-ton travelers have each one 40-ton main and two 5-ton auxiliary trolleys.

The building is heated by the Sturtevant system carrying hot air by underground ducts to discharge through the base of the columns into the shop.

As the visitors journeyed through the shop, Superintendent W. L. Ely and Assistant Superintendent Wm. B. McCann pointed out many interesting features in the arrangement of machines and the routing of materials; thus, machines of a similar character driven by the same electric group drive, and novel reverse motors direct connected to planers. An item making for efficiency is the use of messengers to carry tools for sharpening to and from the tool-grinding room, thereby considerably reducing the idleness of both machine tools and operators.

The itinerary was then to the structural storage yards and sheds, and the power plant. In the east yard, across the street, is the fireproof pattern storage, template and pattern shops.

Any description of the outing would be incomplete without some mention of the generous disposition of the Brown Hoist management in granting to the Cleveland Engineering Society free access to the works.

From the Brown Hoist plant the party walked to the Kirtland Pumping Station, at the foot of East 49th Street, where it was met by Mr. C. F. Schulz, Superintendent and Engineer of the City Water Department, and was conducted by him through the various buildings. The following data pertaining to the pumping station and the chlorination plant, furnished by Mr. Schulz, appeared in the announcement of the trip:

Buildings.

Foundations begun in 1900. Engine house completed 1903. Boiler and coal storage house completed 1904. Total cost of all buildings, \$510,000.

Pumping Engines.

Two Holly Vertical Triple Expansion Crank and Flywheel Pumping Engines (Nos. 2 and 3), erected in 1903. Contract price, \$124,700 each. Weight, 970 tons each. Capacity, 25,000,000 gallons per 24 hours. Diameter of cylinders, 32 inches, 60 inches, 90 inches. Stroke, 5 feet. Diameter of water plungers, 36 inches. Revolutions per minute at rated capacity, 21.89. Jet condensers. Steam pressure, 150 pounds. Water pressure, 80 pounds (about). Duty per million B. T. U., 151,000,000 foot-pounds. Duty per 1,000 pounds superheated steam, 179,000,000 foot-pounds. Indicated horsepower, 966. Water horsepower, 896. Steam per water horsepower hour, 11.07 pounds. Mechanical efficiency, 94.5 per cent.

Two Holly Vertical Triple Expansion Crank and Flywheel Pumping Engines (Nos. 6 and 7), erected in 1912. Contract price, \$112,679 each. Weight, 970 tons each. Capacity, 25,000,000 gallons per 24 hours. Diameter of cylinders, 34 inches, 64 inches, 98 inches. Stroke, 5 feet 6 inches. Diameter of water plungers, 34 $\frac{3}{4}$ inches. Revolutions per minute at rated capacity,

21.356. Surface condensers. Steam pressure, 160 pounds. Water pressure, 108 pounds. Duty per million B. T. U., 160,-000,000 foot-pounds. Duty per 1,000 pounds superheated steam, 193,500,000 foot-pounds. Indicated horsepower, 1,118. Water horsepower, 1,105. Steam per water horsepower hour, 10.23 pounds. Mechanical efficiency, 96.3 per cent.

One Worthington Horizontal, Compound Direct Acting Duplex Pumping Engine (No. 4) with High Duty Attachment, erected at Division Avenue station in 1893. Moved to Kirtland Station in 1905. Contract price, \$55,000. Capacity, 15,000,000 gallons per 24 hours. Diameter of cylinders, H. P. 36 inches, L. P. 72 inches. Stroke, 4 feet. Diameter of water plungers, 36½ inches. Revolutions per minute at rated capacity, 12.142. Jet condenser. Steam pressure, 100 pounds. Water pressure, 80 pounds (about). Duty per 1,000 pounds saturated steam, 125,000,000 foot-pounds. Water horsepower, 560. Steam per water horsepower hour, 15.8 pounds.

Boilers.

Eight Babcock & Wilcox Water Tube Boilers, with B. & W. superheaters, and B. & W. chain grate stokers. Six erected in 1903. Two erected in 1905. Contract price, \$56,834. Water tube heating surface, 2,725 square feet each. Horsepower, 272.5 each. Grate surface, 60 square feet. Steam pressure, 200 pounds (allowed); 150 pounds (at present). Superheat, 150 degrees Fahr. Water evaporated from and at 212 degrees Fahr. per pound of dry coal, 10 pounds. Efficiency, including grate, 73 per cent.

General Pumping Statistics from Annual Report, Year 1911.

Coal consumed for the year.....	53,427,300 pounds
Total pumpage.....	23,977,196,242 gallons
(Without allowing for slip.)	

Average duty, 78,403,133 foot-pounds.

(Note:—This is based on the total coal consumed at the station, including heating, etc.)

Cost of pumping (pumping station expense).....	\$101,631.14
Cost per million gallons pumped.....	4.24
Cost per million gallons raised 1 foot.....	.02

Chlorination Plant.

The temporary chlorination plant, begun on September 11, 1911, and completed at a cost of \$4,900, is housed in a frame building, 28 x 38 ft., two stories high. The equipment consists of two steel solution tanks 12 ft. inside diameter and 8 ft. deep, set on posts about 6 ft. high on the main floor. Between the solution tanks and above them on the second floor is a steel mixing tank

where the chloride of lime, slowly fed from iron drums in which it is received, is mixed with water by a device driven by a three-horsepower gasoline engine.

The chlorine-charged water overflows into one of the solution tanks, where more water is added until a 1 per cent mixture is obtained. After being allowed to settle for a period of five hours or more, the clear liquid is drawn off by a 2-in. galvanized pipe through float valves into two galvanized iron orifice tanks, 3 ft. long, 20 in. wide and 16 in. deep, side by side on the main floor. The orifices, rectangular slots $\frac{1}{2}$ inch in width cut into brass plates, can be changed in area to vary the discharge. About 8 lbs. of bleach are now used for each million gallons of water pumped. When chlorine was first applied, about 20 lbs. per million gallons were used.

Each drum of chloride of lime and each mix of the solution is tested at the laboratory to determine available chlorine. The treated water is likewise tested at the discharge end of each engine and from a faucet in the main after a contact period of 45 minutes. The chemist's books show in the distributing main one fourth as much chlorine as at the discharge ends of the engines.

Mr. Schulz says complaints about chlorine taste or odor in the water are now infrequent and that he tries to get a sample of the water complained about in order to determine in the laboratory just how much chlorine is in it. Health figures, we are told, show, since the chlorination plant was put into service in 1911, a reduction of typhoid cases from 13 to $5\frac{1}{2}$ per 100,000 inhabitants. This reduction cannot, with certainty, be credited to chlorine, Mr. Schulz said, but some of the lessened typhoid rate is doubtless due to a general cleaning up in the city and screening of the summer outhouses against flies. In the bacteriological laboratory, the visitors were told, typhoid germs are seldom found in the raw water and never in the treated. The chlorine is added, Mr. Schulz said, "To make assurance doubly sure."

One reason why water is pumped so cheaply is the economic and scientific way the plant is conducted. Every car of coal is sampled and a test made in the laboratory of its heating value. The coal contract calls for 13,000 heat units in every ton. For every 100 heat units below the contract requirement, $1\frac{1}{2}$ cents are deducted from the contract price and a like amount is paid as a bonus for every 100 heat units above 13,000. Coal is weighed in ton lots before it is fed by gravity to the boilers so the efficiency of each boiler can be watched. Soon tests of flue gases are to be started for the same purpose. Frank expression of commendation was frequently heard from those in the party on the cleanliness and good air in the boiler room.

PROGRESS REPORT OF SMOKE PREVENTION COMMITTEE

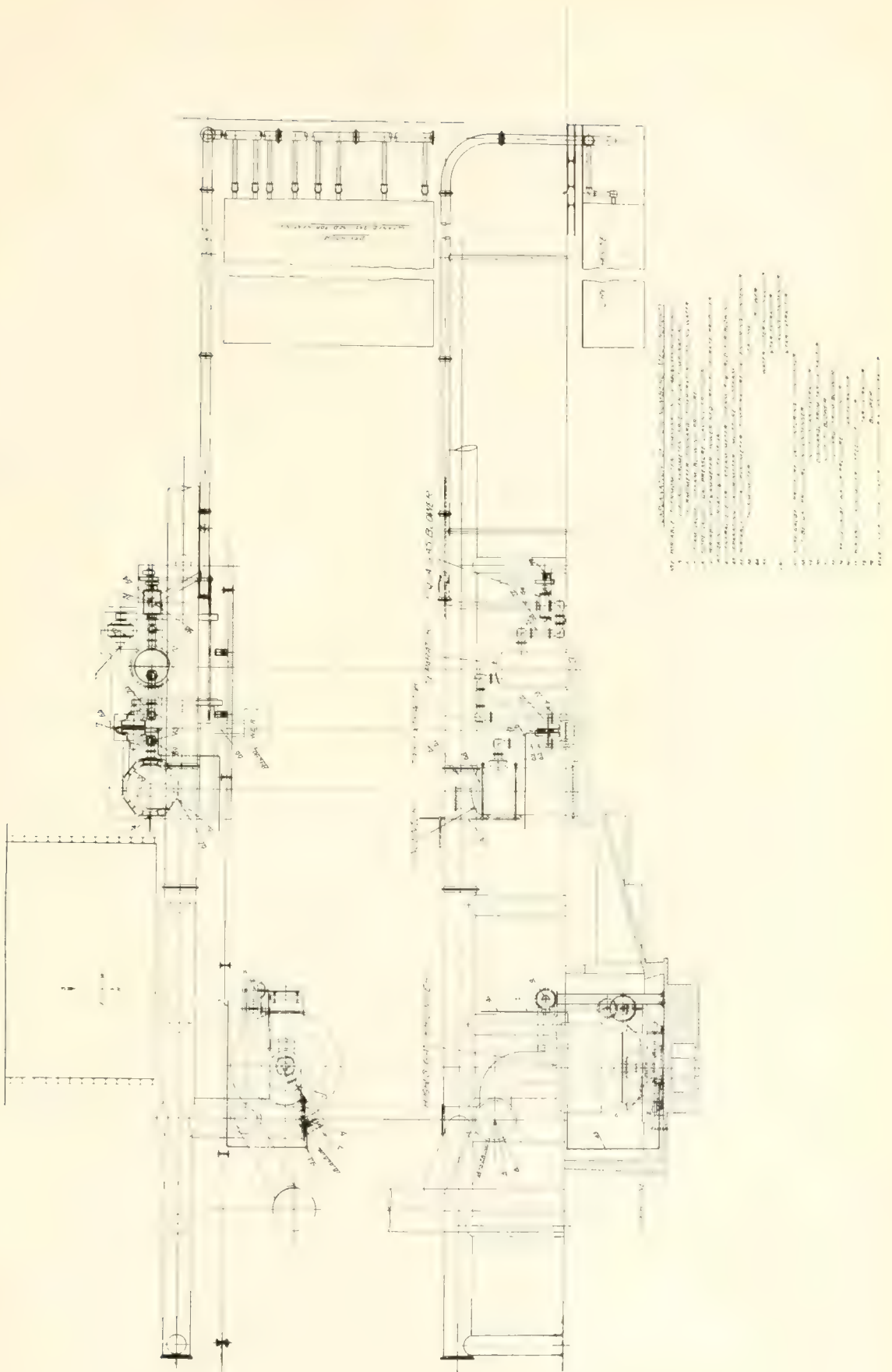
This committee as far as possible have endeavored to get information at first hand covering the construction details and the operation of boiler furnaces that are giving reasonably satisfactory results from the smoke abatement point of view, and have in course of preparation, a report of a test in the boiler house of the Cedar Avenue power house of the Cleveland Electric Railway Company, which was made under the supervision of members of this committee, through the courtesy of Mr. L. P. Crecelius, superintendent of power, C. E. Railway Company. We find it undesirable to give this report in an incomplete form, and will not present it for publication until a later issue of the JOURNAL.

In the numerous and varied works that make a manufacturing center such as Cleveland, the amount of coal burnt under boilers for power purposes is, of course, a large percentage of the total amount of coal consumed, but it must be remembered that in the majority of these plants, smaller furnaces for heating purposes, etc., are being used, in most cases, scattered throughout the works where, of necessity, little attention is paid to expert firing to get the best possible furnace results. These isolated furnaces are the source of a great deal of the smoke that is noticeably hovering over these plants and it seems to our committee that some good work might be done in investigating methods that are being used in this city, or elsewhere, for providing these small furnaces with smokeless fuel, or gathering data to show the necessity for better furnace construction and the advantages of mechanically firing the coal so as to, as far as possible, eliminate these furnaces as a considerable part of the smoke-producing factor of the present time. With this in view, we are presenting as part of our progress report, an extract from a test on Cleaned Producer Gas now in use in one of the plants of the city.

In this particular installation, producer gas of the ordinary composition from Ohio and Pittsburgh bituminous coals is cleaned to a degree of cleanliness represented by 0.015 grain per cubic foot of gas, and while it is not considered necessary to clean to this point for piping clean gas through unlined flueways, this quality of gas was absolutely necessary for other purposes.

The installation, in addition to the gas producer, includes a wet scrubber, a tar extractor, a dry scrubber and a positive displacement pressure blower for building up the gas pressure so that it can be piped through small pipes to furnaces located some distance away from the washing plant.

The quantity of gas cleaned is approximately 45,000 cu. ft. of standard gas per hour, and the process of cleaning reduces the temperature from about 1,200 degrees Fahr. to 130 degrees Fahr., and extracts the tar which was found to be approximately 250 lbs. per net ton of coal gasified in the producer. This cooling of the gas, and condensing of the tar content of the gas is the



cause of the greatest thermal loss between the value of the coal, as charged to the producer and the value of the *cold gas* as delivered to the furnaces, and in this particular installation, contributes to the high cost of the clean gas per million B. T. U. value and would possibly be prohibitive were it not for the necessity of using a part of this gas for other particular purposes.

When any large quantity of cleaned producer gas is used, methods undoubtedly will be provided for utilizing the heat now lost in cooling the gas to the temperature necessary for the extracting of the tar, and the cost will be further reduced on account of the decreased cost per ton of coal gasified by a large battery of producers over the cost herein shown, where a single producer was operated.

The furnaces in which this cleaned gas is being used were formerly fired by coal and were a source of a large percentage of the smoke coming from this particular plant. The gas is burnt through simple burners of the Argand type, through which air is taken at natural pressure, the burners having air dampers for regulating the supply and also for observation of the inside of the furnace. Since the gas has been used on these furnaces, no smoke whatever has been made, and while the cost per unit of work has increased from \$0.12 to \$0.16, the results in uniformity of temperature and also the absence of smoke have constituted a good offset for the small increased cost.

A few results of the test, giving the cost of this gas per million B. T. U. value are given below:

Size of producer.....	10 ft. diameter
Grade of fuel.....	$\frac{3}{4}$ bituminous coal
B. T. U. per lb. dry fuel.....	13,250
Lbs. fuel fired per hour.....	1,570
Cu. ft. standard gas produced per hour*.....	89,700
B. T. U. per cu. ft. of cleaned gas.....	153
Per cent refuse from producer.....	11
Per cent combustible in refuse.....	55
Cost of producing washed gas, including fuel, per 1,000,000 B. T. U. value**.....	\$0.28

*Only 50 per cent of this gas was cleaned, the remainder being used in the raw state.

**Approximately equivalent to 1,000 cu. ft. of natural gas.

JOURNAL

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The Board of Boiler Rules and Its Work

By H. A. BAUMHART.

Steam boiler inspection is a subject which covers a broad field. It is the foundation of practically all industries and commerce. Its first duty is to approve of the design of a boiler and its appendages that would be safe to operate under various conditions. The requirements demand various types and conditions of operation covering space occupied, weight and pressure. It must also provide rules covering the periodical examination of steam boilers during the period of service.

A steam boiler may be described as a vessel in which water is confined to generate steam under a pressure equal to or exceeding that of the atmosphere, for the conversion of its expansive force in a steam engine or motor, or for heating purposes. There are two distinct types of boilers: One known as the fire tube boiler where fire and hot gases pass through the tubes, which are surrounded by water; and the other type is known as the water tube boiler, where the fire and hot gases pass over and around the tubes containing water. Boilers of the fire tube type are more commonly used for locomotive, steamship and portable work.

A plain cylinder boiler was used extensively for power purposes until about twenty-five years ago, when competition in manufacturing forced the adoption of a more economical type of boiler and it is now seldom used. There is also another type of boiler which was used extensively by the manufacturers in the Pittsburg and the Ohio Valley district, and which today is used almost exclusively on river steamers. Its construction consists of a cylinder and usually two flues riveted to the heads. The shells vary from thirty-six (36) to forty-four (44) inches in diameter and the length from twenty-four (24) to thirty (30) feet. The flues are from eight (8) to fifteen (15) inches in diameter according to the number used and the diameter of the shell. This type of boiler has given good satisfaction in localities where fuel was cheap and the condition of the feed water such that frequent cleaning was necessary.

Great progress has been made in the art of steam boiler design and construction during the past twenty years. The improvements in the design of a steam engine have also added very much to economical steam power; the economy consisting principally of a high initial steam pressure made possible because of improved boiler design.

Water tube boilers were first invented about 1767, but were not used extensively until about 1890. They have been growing in favor with the manufacturers, and now the majority of modern power plants are equipped with that kind of boiler. There are two distinct types of water tube boilers. One is of the vertical type and the other of the horizontal or inclined tube type. Various types of water tube boilers have been designed; many of these, when put to the test, were discarded because impractical. We learn nearly as much from the result of failure as from the result of success. Boiler manufacturers and engineers have profited by this, with the result that only a few so-called freak boilers now appear on the market. A steam boiler is the principal part of a power plant, whether it be to operate a factory, a train of cars or a steamship. Many operating engineers have given practically all of their attention to the study of the steam engine, consequently, but few of them understand the care and skill necessary in designing a steam boiler to make it safe, durable and economical to operate. It has been the custom to depend solely upon the boiler manufacturer to furnish a boiler to meet certain requirements. Boiler manufacturers have not agreed upon the requirements, and the result has been the installation of boilers of various dimensions and various factors of safety for the same purpose. Several insurance companies were organized, one several years ago, for the purpose of inspecting steam boilers and guaranteeing their safe operation under certain standards; others organized later to write insurance policies covering general liability and including steam boiler. Some of those companies' inspectors were either incompetent, or paid little attention to a proper factor of safety, and the result was no standard of efficiency in boiler inspection service. It sometimes occurred that when one company condemned a boiler or insisted upon a reduction in pressure, a competing company would accept the risk and restore the pressure.

I desire to call attention to the statistics concerning boiler explosions. By referring to the records kept by the Hartford Steam Boiler Inspection & Insurance Company, I find that in the United States during the year 1911, there were 499 boiler explosions, 222 persons were killed, 416 persons were injured, the total killed and injured being 638, and during the year 1912, there were 537 explosions, 278 killed, 392 persons injured, the total killed and injured, 670. The annual property damage is estimated at one-half million dollars, this being a fair average for the past ten years. Disastrous explosions are not confined to any particular type of boiler. The majority of boiler accidents occur on water tube boilers, which is due to the numerous tube failures, some of which are trivial. So-called safety water tube boilers do explode, however, with disastrous results. I would refer you to the explosion which occurred on the twenty-first day of December, 1903, in the Geyer Avenue plant of the St. Louis Traction Company, St. Louis, Mo. Seven water tube boilers exploded simultaneously; six of them blown to pieces,

while the seventh had fifty-two of its tubes blown out and was itself thrown into the street. There were eight men killed and twenty-one injured. The buildings and machinery that were destroyed covered an area of something like 30,000 square feet, and were valued at about \$75,000. Those boilers were of the horizontal or inclined water tube type.

There was the explosion of the 400-H. P. water tube boiler which occurred on June 15th, 1909, in the plant of the Denver Gas & Electric Company, located at Sixth and Curtis Streets, Denver, Colo., which killed four (4) men; the property damage was estimated at \$60,000. This boiler was of the vertical water tube type.

I will now refer to the explosion of fire tube boilers, or boilers of the horizontal tubular type. On November 26th, 1901, a horizontal tubular boiler exploded at the works of the Penberthy Injector Company, at Detroit, Mich. The property loss was estimated at \$100,000, and the explosion and subsequent fire and destruction of the building which followed, resulted in the death of thirty-seven persons.

On March 20th, 1905, a steam boiler exploded in the factory of R. B. Grover Co., manufacturers of shoes, at Brockton, Mass. Of the two hundred persons in the collapsed part of the building, no less than fifty-eight died, and one hundred and seventeen others were injured. The loss was estimated at \$200,000.

On December 6th, 1906, a boiler explosion occurred in the factory of the P. J. Harney Shoe Company, situated at West Lynn, Mass. The explosion occurred just before seven o'clock in the morning, when only about a score or so of the operatives had entered the building, and owing to this fortunate circumstance, there were no deaths to report. Seventeen persons were injured, however, some of them seriously. Fire followed the explosion; the total loss from fire and explosion was estimated at from \$500,000 to \$600,000, and the immediate loss from the explosion proper, as distinguished from the consequent fire, was estimated at \$18,000.

A more recent boiler explosion, which is no doubt fresh in your minds, is the explosion which occurred at the plant of the American Sheet & Tin Plate Company, Canton plant, Canton, O., in May, 1910, which resulted in the death of thirteen persons and thirty-three seriously injured. The property damage in that case was estimated at \$18,000.

This shows that it does not matter which type of boiler it is which explodes, the result is about the same. The above disasters would have been less likely to occur had the boilers been constructed, inspected and operated under the Ohio boiler inspection rules. Those conditions brought about an agitation for a standard boiler inspection rule and eventually resulted in a compulsory boiler inspection law in some localities.

Laws protecting the public and the safety of employes usually follow a calamity. The serious boiler explosions which
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occurred in the state of Massachusetts in 1907 resulted in the revision of their boiler inspection rules, and the explosion at Canton, O., in 1910, did, no doubt, hurry the enactment of the Ohio boiler inspection law.

In an endeavor to protect the public from the recognized dangers attending the operation of steam boilers, a few states and several municipalities for years past have had laws requiring the periodical inspection of boilers. Many of these laws were, however, practically worthless owing to the fact that no rules or regulations were prescribed to guide the inspector in determining what was safe practice.

The subject covers so large a field that it will not permit discussing the technical points in one evening, and I will, therefore, mention only the principal conditions respecting the construction, safety of operation, and the rules formulated by the Ohio Board of Boiler Rules, which govern the construction and inspection of steam boilers in this state.

The material entering the construction of a boiler is the first important question. Iron was necessarily used in boiler construction until about 1880. A very high grade of iron plate was manufactured, having a tensile strength of 45,000 lbs. per square inch, durable, and its deterioration was slow; in fact, there are a few iron boilers still in use. The first steel boilers were made, I believe, by the Kendall & Roberts Company, of Boston, Mass., in 1877. Since 1880 steel boiler plate has replaced iron. The first steel boiler plate used in this locality was made in our city by the Otis Steel Company.

Great care is necessary in the preparation of steel for boiler plate. It is a well-known fact that the principal ingredient in steel is carbon. Other ingredients beside carbon are also present in steel, two of which are sulphur and phosphorus, but only traces of these two can be permitted in the best quality of boiler steel; the most injurious of these is phosphorus. A report of analysis made of boiler plate which developed cracks either in the boiler shops or after the boiler was in service, showed that phosphorus exceeded 0.04 per cent. It is essential, therefore, when specifying boiler plate that the chemical analysis shall show that phosphorus does not exceed 0.035 per cent, and 0.02 per cent is preferable.

The Ohio boiler rules specify open-hearth steel. The percentage of phosphorus shall not exceed 0.03 per cent for fire box steel and 0.04 per cent for flange or extra soft steel; sulphur shall not exceed 0.05 per cent for flange steel and 0.04 per cent for fire box or extra soft steel; manganese shall not exceed 0.06 per cent for flange steel, and 0.05 for fire box or extra soft steel. The physical properties required are a minimum tensile strength of 55,000 lbs. and a maximum of 65,000 lbs. for flange steel, and 52,000 lbs. to 62,000 lbs. for fire box steel, and 45,000 lbs. to 55,000 lbs. for extra soft steel. A certified copy of mill test report must accompany each plate entering the construction of the boiler. The material entering the shell of the boiler and

butt straps must be of fire box or extra soft steel grade. The heads, furnaces or any plate that requires staying or flanging shall be of open-hearth flange, fire box or extra soft steel; rivets shall be of open-hearth extra soft steel.

Cast steel for use in a boiler, superheater, mountings, man-hole frames, steam pipe, fittings and side lugs or any other part of a boiler or superheater where cast steel is used, shall not have less than 50,000 lbs. tensile strength. Cast iron, where permitted to be used, shall not have less than 18,000 lbs. tensile strength.

Braces and stay bolts may be of either steel or wrought iron. A variation of 500 lbs. per square inch of section in favor of the weldless brace is provided for. The rules also specify the maximum pitch of stay bolts permitted for various thicknesses of plate and pressure.

In the matter of workmanship, it is necessary that the rivet holes and tube holes be either drilled full size or punched $\frac{1}{4}$ inch to $\frac{1}{2}$ inch small and reamed to size, all parts well fitted and the general character of the workmanship throughout to be first class in every respect.

The additional cost of constructing a boiler under the Ohio rules over that of a commercially-built boiler is about 20 per cent. The life of a boiler constructed under the Ohio inspection rules will be 50 per cent longer in point of service and the danger from explosion greatly reduced.

At first steam users objected to the increased cost of construction. They soon learned that the extra amount expended for a better article was off-set by increased length of service, cost of repairs, and safety of operation. Many purchasers of steam boilers now take advantage of this condition, and when ordering a boiler, specify that it shall be constructed "Ohio Standard", although not intended for installation in this state.

Massachusetts was one of the first states to enact a law requiring the annual inspection of steam boilers used in that state: it was of the generally inefficient character. This law was amended in 1907 and made thoroughly efficient by a provision for a Board of Boiler Rules, which was given authority to prepare rules and regulations governing the construction, installation, operation and inspection of practically all the steam boilers for use in the state of Massachusetts. In due time after this Board was appointed, a set of rules was prepared, and these rules, as amended from time to time, have now been in use for a sufficient period to demonstrate their general value.

In 1910, the National Association of Stationary Engineers of Ohio took up the subject of a boiler inspection law for this state, and after careful consideration, it was concluded that a law similar to that in force in Massachusetts would accord the greatest safeguard to human life and property, and was most likely to be free from political influence. The Association accordingly prepared a bill which became a law by the signature of Governor Harmon on June 14th, 1911. This law provided for the establishment in the office of the Chief Examiner of May, 1913

Engineers, at Columbus, of a department to be known as the Board of Boiler Rules, to consist of the Chief Examiner of Engineers, as chairman, and four members to be appointed by the Governor. One of these is to be an employe of the boiler-using interests, one an employe of the boiler-manufacturing interests, one an employe of the boiler insurance interests, and one an operating engineer.

The duties of this board are to provide rules and regulations for the construction, installation, operation and inspection of steam boilers, and the devices with which they are equipped. The board was also to pass on any plans that might be deemed necessary to the safe operation of steam boilers, and to prescribe a standard form of certificate of inspection; also to examine all applicants for certificates as boiler inspectors.

It was provided in the law that on or after January 1st, 1912, all steam boilers and their appurtenances (with certain specified exceptions), should be thoroughly inspected, internally and externally, and under operating conditions at intervals of not more than one year. It was also provided that such boilers should not be operated at pressure in excess of the safe working pressure stated in the certificate of inspection and that they must be equipped with such appliances to insure safety of operation as may be prescribed by the Board of Boiler Rules.

The specific exceptions exempt from the operation of the law are, boilers of railroad locomotives, portable boilers used in pumping, heating, steaming and drilling in the open field, for water, gas and oil, and portable boilers used for agricultural purposes and in construction of any repairs to public roads, railroads and bridges, boilers on automobiles, boilers under the jurisdiction of the federal government. Boilers for heating are also exempt if operated at pressures below 15 lbs. per square inch and provided with approved safety devices.

To avoid extra expense and also to standardize the inspection work, the bill was made to provide for two classes of inspectors, one to be known as General Inspectors in the employ of the state, and the other to be known as special Inspectors, in the employ of an insurance company authorized to insure boilers. These two classes of inspectors were to work under the same rules and regulations governing the inspection of steam boilers. Each inspector must be examined and obtain a certificate of competency. A fee of \$10.00 must accompany an application for examination for a certificate of competency as an inspector. After a certificate has been granted, the successful applicant is not authorized to inspect boilers for the state until a commission is granted him by the Chief Inspector of Steam Boilers. A commissioned inspector is not authorized to issue an inspection certificate; but it is his duty to forward a report covering the condition of the boiler, including its dimensions, to the Chief Inspector of Steam Boilers, at Columbus, Ohio, by whom, if he approves, a certificate is issued. The law requires a fee of 50 cents for each certificate issued, which is collected by the department at Columbus, Ohio.

The state of Ohio ranks among the largest in manufacturing and mining industries, and probably has within its borders 25,000 steam boilers, 18,000 of which became, on January 1st, 1912, subject to the rules governing their inspection. The state of Ohio, up to that time, had never had a boiler inspection law. Its steam users and boiler manufacturers, therefore, were familiar only with such inspection requirements as the steam boiler insurance companies imposed, and in most cases the pressure allowed was that determined by the boiler manufacturer or an insurance company's inspector, when insured. As power plants are designed to operate with a certain fixed minimum pressure, it was realized that any reduction to permit of a fully adequate factor of safety, unless given time for making changes, would in many cases, cause a great hardship. The factor of safety under which some of the boilers were operated was problematical, but judging from personal observation, a considerable number had a factor of safety of 5, a few less than 4; the majority of boilers are operated at a factor of safety varying between 4 and 5. The question most difficult for the Board to decide was, what should be the minimum factor of safety for boilers already installed, and at what time in point of service should the pressure be reduced in order to maintain safe operation and not create an unnecessary expense or hardship or perhaps, in some cases, compel the mine or factory to close to avoid violation of the law.

The Massachusetts boiler law places the minimum factor of safety at 5 in every case and this is increased when the boiler is ten years old. This high standard was obtained after several years of educational work in that state. It would seem to be an injustice to the steam users to extend that rule to Ohio at this time. The minimum factor of safety generally used in Ohio for the past ten years was 4. It was thought that this factor could be safely extended to cover all boilers already in use in Ohio until the steam users could become accustomed to a higher standard and arrange conditions to meet it. It was, therefore, recommended that the minimum factor of safety for boilers already installed be placed at 4, for boilers installed after July 1st, 1912, the minimum factor of safety to be 5, and that the inspector should increase this when the general condition of the boiler required it. This rule was unanimously adopted by the Board, and it is now a law.

When formulating the part of the rules governing boilers to be installed after July 1st, 1913, the Board considered in addition to safety, the question of standard boiler construction. Some states and several cities have boiler inspection laws, which differ in but minor details, but this difference is sufficient to prevent a boiler designed for one locality from being installed in another, although meeting all the requirements of the law at the first location. Boiler manufacturers are placed at a serious disadvantage because of this situation, for it thus becomes necessary to know where the boiler is to be installed before it can be designed; a condition which tends to increase the cost of production. Man-

ufacturers and contractors whose business requires the use of temporary steam power are inconvenienced by being prevented from removing boilers from one locality to another because of this difference in the inspection laws. Boiler manufacturers and steam users generally requested that the rules covering the construction of Ohio standard boilers be made similar to those adopted by the state of Massachusetts, believing that if Ohio followed those rules, it would be an incentive for other states to follow them, when inspection laws were enacted.

I want to say a few words with reference to the life of a boiler. The subject of a proper retiring age for old steam boilers is one which comes frequently to light, and which has been in the past a most fruitful source of controversy. Of course there can be no question as to the propriety of condemning to forced retirement those boilers whose diseases of one sort or another have reached the chronic stage, and are no longer curable, but there is at once the basis for a deal of argument when an inspector approaches the owner of a boiler with the statement that it must be replaced because of old age, especially if it is known to have all the apparent qualifications except youth, for many additional years of service.

In the past many curious properties have been attributed to old boilers; one of the most interesting was the notion that they could not explode violently. It was supposed that an old boiler would merely rupture, allowing the pressure to be relieved much as if the safety valve had opened. This idea was definitely disproved, along with many other fallacies and much popular mystery concerning boiler explosions, by a series of experiments conducted by eminent engineers. It is a well known fact that some boilers are older in point of service at five years than others are at twenty years. The condition under which they are operated must govern. A boiler constructed with a high factor of safety for the pressure under which it is operated, and which has not been over-heated to the extent of changing the quality of its material, is not old, although it may have been in service twenty years. We all know that steel used in boiler construction will deteriorate with use. Boiler material undergoes a slow loss in strength and ductility. This process is slower for steel than for iron and the presence of a moderate excess of phosphorus hastens the process. Depreciation of this character cannot be determined by the usual method of inspection. It is, therefore, difficult to state definitely at what time in service the boiler should be abandoned. It places a great responsibility upon the inspector. He must consider, in addition to the general appearance of the boiler, the conditions under which it is operated, and he must make allowance for defects in the material which are not visible. This sometimes results in criticism of the inspector's work, and he is frequently accused of condemning a boiler too soon. Because a boiler is considered unsafe for further use does not imply that we can predict the day and the hour when it will explode; it does imply, however, that the

factor of safety is too low, and to continue the boiler in service for any considerable length of time presents a hazard too dangerous to be undertaken.

The law states explicitly that no certificate of inspection shall be granted on any boiler installed in Ohio after July 1, 1912, which does not conform to these rules.

Under the Ohio law, all boilers must be inspected at the place of manufacture by an authorized inspector, and stamped by the manufacturer in the presence of the inspector before shipment. This may appear an unnecessary expense, but it has been found in practice to be necessary to insure compliance with the rules. These rules have been in force one year and I believe are giving universal satisfaction.

No mysterious agency enters a boiler to cause an explosion. A steam boiler explodes or fails from one cause only, and that is the fact that the boiler or the part which fails could no longer resist the strain placed upon it. The applied pressure may be sufficient to rupture a sound boiler, or the boiler may have reached such a state of deterioration that the ordinary working pressure becomes an over pressure. In the majority of serious explosions, the primary cause was due to the lap seam form of construction. The Ohio Boiler Inspection Rules prohibit that form of construction for boilers exceeding 36 inches in diameter, or for pressures exceeding 100 lbs. Explosions also occur from improper care and management of the boilers by permitting an excess pressure, sometimes due to a defective condition of the steam gauge, safety valve or gauge cocks, or a condition of low water. Explosions due to a condition of low water, however, are usually less violent than when caused by an over pressure.

The primary cause for a boiler explosion is sometimes due to a deposit of scale and sediment or oil on the internal surface, improper reinforcement of opening, gradual reduction of the metal by corrosion, or overheating of shell or tubes due to excessive heat.

A correct boiler design is one of particular interest to the manufacturer and must include, in addition to the proper factor of safety, other conditions which are also of vital importance to safety of operation. A rigid part of the cylinder should not be joined to a thinner or more flexible one. The entire ring should be of the same thickness and the covering straps at the riveted joints should be bent to the proper curvature to insure uniform flexibility. The tubes must be securely joined to the heads or manifolds by either flaring or beading the ends. The boiler must be accessible for cleaning and inspection, and the furnace arranged to avoid localization of heat.

A boiler is frequently constructed too light for the pressure. This does not mean that the boiler would explode as soon as the pressure is raised. It does follow, however, that the metal will gradually weaken, and the failure may not occur until several years thereafter. To illustrate this point more clearly, and to prove that metal does weaken under stress, I refer to a report May, 1913

relating to a test of material. At a factor of safety of 2 the number of repetitions of stress required to produce rupture was 20,000. At a factor of safety of $2\frac{1}{2}$ —210,000; at 3—700,000, and $3\frac{1}{2}$ more than 1,600,000. It would, therefore, follow that boilers operated under a factor of safety of less than 4, because of the uncertainty of the material and the so-called fatigue of metal under stress, should not be used. A condition which frequently occurs, and always with some danger, is the fact that a manufacturer will purchase a boiler constructed for a working pressure of say 100 lbs. This pressure is entirely satisfactory and will furnish power for a time. As the demand for power increases, as is usually the case, it develops that the only way to increase the power is to increase the boiler pressure. Such conditions are not advised and are not permitted under the Ohio Boiler Rules.

The force of a boiler explosion is measured by the amount of water in the boiler and the temperature of it at the time of explosion. The temperature of the water in an open vessel does not exceed 212 degrees Fahrenheit, but when confined, the temperature increases with the pressure. It therefore follows that when the pressure and water are suddenly released by a rupture of the boiler, the water will, because of its high temperature, almost instantly turn into steam, and with the enormous volume of steam thus generated, produce results similar to the action of gun powder. The failure of a vessel containing steam only is less violent.

No inspection service, whether conducted by the government or by the insurance company, can prevent a boiler explosion or a serious accident if the boiler or machinery be in charge of an incompetent or careless person.

On December 29th, 1910, a boiler at the plant of the Norwood Ice Company, at Pittsfield, Mass., exploded, causing the death of 17 persons. This boiler was inspected under the provisions of the Massachusetts Boiler Rules. This proves that in spite of the advanced precautions that science has provided, reliance must still be placed in human intelligence and faithfulness to a large degree, and sometimes that fails. The boiler owner or user is morally responsible for its safety. It is his duty first to provide safe boilers, and then select only such persons as are fitted to care for them.

In conclusion, I wish to mention the question of automatic boiler appliances. There are, as you know, a number of such devices, including automatic feed water controllers, low water alarm whistles, gauge glass connections with self-closing valve in case the glass breaks, damper regulations, etc. Some of these devices aid in the economical operation of the plant; others are of doubtful value, and the only argument in their favor is a reduction in the amount of labor. My advice to the engineer operating boilers equipped with automatic appliances is, "Don't depend upon them entirely, but try the gauge cocks frequently and note particularly whether there is water or steam."

The subject of my paper, if extended to include minor details

of steam boiler construction, would fill a book. I have therefore covered only conditions which led up to the enactment of a compulsory boiler inspection law and in a general way the rules governing the inspection.

March 18, 1913.

The Gas Producer and Producer Gas

By C. D. SMITH.

The development in many of our industries has depended upon the development in the utilization of fuel. From a historical standpoint by far the greatest progress, in the use of fuel, has been in comparatively recent times, and during this progress many difficulties have been encountered; and there have been successes and failures in the various schemes for more efficient utilization of fuel. The sum total of successes marks the progress made, and the failures, perhaps, have led to a feeling of mistrust and even opposition on the part of many when new fuels or new methods were imposed.

At the present time, one of the comparatively new fuels is producer gas; it has been made, however, and used for about 70 years, but the greatest development in its application to industrial pursuits has taken place within the last ten or twelve years, and it is probably during this period that its virtues and its apparent faults have been most generously proclaimed. As a matter of interest let us review very briefly the early history of some of our principal fuels:

We have no record of the time when the human race first used fire for its comfort and welfare, but in all the ages of the unknown past it is probable that wood has been the principal fuel and that very little use was made of mineral fuel.

In these days of industrial activity and smoky cities, it is of interest to note that coal was subjected to severe abuse and criticism in its early days. The ancients appear to have been acquainted with coal and with the fact that it would burn, but the available records indicate that but very little coal was used previous to the thirteenth century. It is said that as late as 1769, when wood was very dear in Paris, an attempt was made to substitute coal shipped from England; there was at once a general outcry, the coal was accused of vitiating the air, of soiling the linen, of affecting the lungs, and worst of all, of impairing the delicacy of the female complexion. In spite of protests and appeals, the obnoxious fuel was expelled from the city. Somewhat earlier records show that at one time in England the penalty for using coal was the immediate destruction of the furnace in which it was burned. However, the consumption of coal gradually increased, and about the year 1800 it is said that the annual consumption of coal in England was something like 10,000,000 tons.

The first practical application of gas distilled from coal was made in 1802 by William Murdoch, whose experiments resulted in lighting a factory near Birmingham. It had been known for a hundred years preceding this event that a combustible gas

could be made by distilling coal, but it was made only in small quantities and in an experimental way. Murdoch's application of the gas for lighting purposes was at the time considered a wonderful achievement of science and art. However, the new light had to struggle for a time against prejudice and misrepresentation. In 1807, the first public street gas lighting took place in Pall Mall; in 1812 the Chartered Gas Light & Coke Co. was incorporated and granted a charter, and the following year Westminster Bridge was lighted with gas. Clegg, the energetic manager of the new company, and to whom its success was undoubtedly due, had to light the gas lamps on Westminster Bridge himself, such was the dread which the inflammable gas inspired. When it was introduced into the House of Commons the architect insisted that the mains should be placed a certain distance from the walls to prevent (as he said) the heat from the pipes setting fire to the building. Sir Joseph Banks and a committee of the Royal Society visited the company's works to report on the expediency of allowing large volumes of gas to be stored and were amazed to see Clegg drive a pickaxe into a gas holder and light the issuing gas with impunity. But the opposition was comparatively short-lived, and in 1816 gas lighting became common in London. After this time the progress of the new mode of illumination was very rapid.

In the development of modern industry, petroleum has been a very important factor. This substance has been used for medicinal purposes from the earliest historic periods and that it would burn has also been known for a long time, but until 1859 the production of petroleum amounted to only a few barrels annually and its value was unrecognized; since that time the production of petroleum has increased at an unprecedented rate and the magnitude of the oil industry that has been built up within the memory of men now living is truly marvelous. As with coal and coal gas, so petroleum had to fight its way during the first few years of its exploitation; failure after failure was the reward of all efforts to utilize petroleum for illuminating purposes, and even after a fairly satisfactory light had been made by purifying the oil, the unbearable odor and danger from fire made it difficult for the new product to gain favor. At the present time the number of products obtained from petroleum and the extent of their application to modern industry is so great that any curtailment in the supply becomes a matter for serious consideration.

Closely associated with the development in the utilization of petroleum, properly belongs that of natural gas, inasmuch as they are generally found together. The existence and combustible nature of gas has been known for a long time, but its general use for domestic and industrial purposes did not take place until about 1883, and in the 30 years since that time great quantities have been consumed and almost inconceivably great quantities have been wasted. Its utilization is confined to those dis-

tricts in which it is found, and to the territory to which it may be found practical to extend pipe lines.

The introduction of natural gas for general use was not attended with as many difficulties in gaining a recognized standing as was experienced by some of the earlier fuels, although a considerable amount of experimenting was necessary. Its high heat value, the readiness with which it burned and familiarity with coal gas undoubtedly helped to hasten its use.

In natural gas we have our nearest approach to an ideal fuel for light, heat and power. It is convenient, requires no store house, produces no ashes, and if proper care is exercised, may be used for domestic or manufacturing purposes with as much safety as any other fuel. The multiplicity of uses to which natural gas has been applied, has led to a much greater appreciation of gaseous fuel and has helped to develop industries and effect economies hardly attainable with other fuels. Unfortunately, the supply of natural gas is not unlimited; in a few fields there is already a marked falling off in the supply and in some cases it has failed altogether.

With such fuels as natural gas and fuel oil, many heating processes have been developed to a rather high degree of perfection, but with the end of the supply of great quantities of natural gas apparently in sight, and a decrease in the supply of fuel oil accompanied by rapidly increasing prices already at hand, there is no little concern. It is felt that there can be no retrogression in methods; that fuel costs cannot be very much increased, but that the problem is to find some cheap fuel which, when properly applied, will meet satisfactorily the demands.

To this problem, the gas producer apparently offers the only solution. It is to the gas producer also that we look for a supply of cheap gaseous fuel to meet the growing demand in many industrial lines. What, then, is a gas producer? What is producer gas? How does it compare with other fuel gases, and what are its limitations?

As was previously stated, producer gas has been employed for industrial purposes about 70 years, but of this period the first 25 years was little more than experimental. An Austrian by the name of Bischof is usually credited with the first gas producer, built in 1839. It consisted simply of a furnace for carrying a deep fuel bed, and was provided with a grate upon which the fuel rested and through which air was drawn by the natural draft of a chimney, this chimney being attached to a metallurgical furnace in which the producer gas was burned. In 1840, Ebelmen built a producer for operating a puddling furnace at the iron works of Audincourt, in France. For a number of years the success of these early producers was uncertain.

In 1861 the Siemens gas producer was built. This type, which was the first producer that was commercially successful, was the real starting point of the gas-producer industry. The Siemens producer was used extensively for metallurgical pur-

poses, and for this class of work in the iron and steel industry there are now many installations of producers essentially the same in principle.

The development of modern producer-gas power apparatus had its start in the introduction of the Dawson gas producer, in 1878 and in 1895. The first successful suction gas producer was built in France, and marks the beginning of the use of small-sized gas-power units. Within the last ten or twelve years the development of the large gas engine and a recognition of the advantage of gaseous fuel for various heating purposes have given a new impetus to the design and construction of gas producers.

Practically all of the gas producers made today will readily come under one of three general types: 1st, the suction plant; 2nd, the pressure plant; and 3rd, the down-draft plant.

In a general way a gas producer consists of a cylindrical shell lined with fine brick and provided with a charging hopper, gas outlet, air inlet, and such other minor accessories as may be required by the particular design; for example, vaporizers, pre-heaters, poke holes, etc. In the suction plant, gas is generated only as used, and is drawn from the producer by the action of the engine piston during what is called its suction stroke; at the same time sufficient air and steam to produce the gas is drawn through the fuel bed. The quantity of gas drawn into the cylinder during each suction stroke depends upon the load on the engine, consequently, the quantity of gas generated is largely regulated by the demands of the engine, and when the engine stops, the generation of gas stops.

In the pressure or updraft plant, air and steam pass into the producer and up through the fuel bed under pressure; the gas generated thus leaves the producer under pressure and is conducted through pipes or other suitable passages to such points as may be desired for its consumption, whether it be for engines or heating furnaces.

In the downdraft producer, the air for combustion enters above the fuel bed, and the gas outlet is from beneath the grate. Fuel is charged at the top and because of the downward draft all volatile matter which is soon distilled from a fresh charge of coal also passes downward and through the incandescent fuel bed. This burns or breaks up into fixed gases the tarry vapors which are found in considerable quantities in gas from pressure producers when the fuel is bituminous coal. These tarry compounds often give rise to much trouble and the particular object of the downdraft producer is to make a tar-free gas.

The double zone producer is a combination of the principles of updraft and downdraft in which an attempt is made to combine the advantages of both systems without including the disadvantages of either.

In making ordinary coal gas or city gas, the coal is subjected to destructive distillation and in this process it is necessary to apply external heat; the gas produced is high in illuminating con-

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stituents and has a comparatively high heat value. Only certain types of coal are suitable for making city gas, and of these the best grades produce on an average of about six cubic feet per pound of coal. By this method only the volatile part of the coal is utilized for gas making and consequently the fixed carbon or coke is left in the retorts as a by-product.

In making producer gas, no external heat is required and all of the combustible portion of the fuel is utilized; air, usually with a certain amount of steam, is passed through a deep bed of incandescent fuel. The oxygen of the air probably combines with the carbon of the coal in the lower part of the fuel bed to form carbon dioxide, and liberates an amount of heat equivalent to the full heat value of the carbon thus consumed. Because of this heat, that portion of the fuel-bed directly above the combustion zone is heated to incandescence and as the carbon dioxide passes upward, through the incandescent zone, a reduction takes place, carbon monoxide being formed while heat is absorbed; the amount of heat absorbed, however, is not equal to that liberated by the first reaction when oxygen and carbon unite to form carbon dioxide. For example, one pound of carbon in carbon monoxide has only 70 per cent of the heat value of one pound of free carbon, and in the producer the other 30 per cent exists as sensible heat and it is sufficient to produce extremely high temperatures within the fuel bed. In practice, however, all of the carbon dioxide is not reduced to carbon monoxide and, therefore, the quantity of sensible heat within the producer is greater than the 30 per cent just mentioned. High temperatures are very favorable for the reduction of carbon dioxide to carbon monoxide and for practically complete reduction extreme temperatures are necessary. Laboratory experiments^a on the rate of formation of carbon monoxide from carbon dioxide in the presence of incandescent coke show that the percentage of carbon monoxide which may be formed depends upon the temperature at which the reaction takes place and upon the time of contact; also, that for a given temperature and a sufficient time interval the reaction will reach an equilibrium at which chemical actions balance and there results a mixture of carbon dioxide and carbon monoxide; the higher the temperature, the higher will be the proportion of carbon monoxide, providing the time element has been sufficient for the reaction to reach equilibrium.

At a temperature of 1,650 degrees F., and a time interval of 142 seconds the percentage of carbon monoxide was found to be 27.8; at this same temperature and a time interval of about 9.5 seconds, the carbon monoxide was found to be only 2.3 per cent. At a temperature of 2,000 degrees F., and a time interval of 90 seconds the percentage of carbon monoxide was 97.1, and with a time interval of about one second the percentage decreased to 12.1. At a temperature of 2,370 degrees F., and a time interval of about 4.2 seconds the percentage of carbon monoxide was

^a—Bureau of Mines Bulletin No. 7.

99.7, with 2.1 seconds it was 95.5 and with 1.1 seconds it was 81.6 per cent.

These figures indicate that for high percentages of carbon monoxide it is essential to operate at high temperatures, but even with a complete reduction of carbon dioxide to carbon monoxide the loss of heat is 30 per cent as previously mentioned. In operating commercial producers of the type now available, there are considerations which argue against maintaining such high temperatures; ordinary fire brick linings will not stand up, and clinker formations give rise to serious difficulties. But when steam is introduced with the air blast the temperature may be maintained at a point just below the fusion point of the ash; much of this sensible heat is absorbed by the decomposition of the steam, and the resulting hydrogen renders it available when the gas is burned. Under these conditions a rather high percentage of carbon dioxide is unavoidable.

Three kinds or types of gas may be made in the same producer, depending upon the method of operation. When dry air alone is used for the blast, the resulting gas is known as air gas and its principal combustible is carbon monoxide. When the air blast carries with it steam or water vapor, the resulting gas is called mixed gas and it contains hydrogen in addition to carbon monoxide; the amount of hydrogen, within certain limits, depends upon the quantity of steam or water vapor introduced. When steam alone is used the resulting gas is termed water gas, the combustible constituents of which are hydrogen and carbon monoxide, as in mixed gas, but they exist in quite different proportions; water gas is also low in nitrogen, although in air gas and mixed gas nitrogen makes up more than 50 per cent of the volume, and nitrogen is an inert element which only dilutes or weakens the gas. In the case of water gas it will, of course, be realized that steam alone can be used continuously for only short periods of time; as this process cools the incandescent fuel body very rapidly, air must be used at regular intervals, alternating with the steam in order to keep the fuel bed at the proper temperature. These three kinds of gas cover a considerable range in heat value, varying from about 100 heat units per cubic foot for air gas, to 275 heat units per cubic foot for water gas. In the manufacture of these gases, it is found that the composition will vary considerably from time to time unless the process is under careful control.

The same essential constituents are found in all kinds of fuel gas, but in such widely different proportions that the gases resulting from the different systems of manufacture vary greatly in their range and manner of commercial application. The constituents of fuel gas may be divided into two distinct classes, the combustible gases and the non-combustible gases, and they usually include the following:

First, the combustible gases,—hydrogen, carbon monoxide, methane and ethylene; and second, the non-combustible gases,—nitrogen, oxygen and carbon dioxide.

The non-combustible constituents, of course, add nothing to
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the heat value of a gas, while on the other hand they do dilute and weaken it to a great extent, but in the manufacture of producer gas where air is used these diluents cannot be avoided. The proportion of combustible constituents and the relative percentages of each in a fuel gas determine its heat value.

Of the industrial gases, natural gas is one of the highest in heat value, being about 1,000 B. t. u. per cubic foot. It consists chiefly of methane with small amounts of other gases which vary in different localities. City gas has a heat value of about 650 B. t. u. per cubic foot, and its composition will average about as follows: Methane, 39 per cent; hydrogen, 46 per cent; carbon monoxide, 8 per cent; ethylene, $3\frac{1}{2}$ per cent; nitrogen, about $2\frac{1}{2}$ per cent; less than 1 per cent of carbon dioxide, and usually a trace of oxygen.

The heat value and composition of producer gas is variable, depending upon the nature of the fuel, the type of apparatus and the method of operation. With good bituminous coal and a pressure producer furnishing gas for power, the following is a typical analysis: Carbon dioxide, 7.2 per cent; carbon monoxide, 23.1 per cent; hydrogen, 15.2 per cent; methane, 1.9 per cent; and nitrogen, 52.6 per cent. This gas has a heat value of 154 B. t. u. per cubic foot and from one pound of this coal about 70 cubic feet of gas may be produced.

With a given fuel and producer equipment there are a number of factors in connection with the operation of a plant which may affect the composition and quality of the gas produced, such as: Variation of load; distribution of air and steam blast; thickness of fuel-bed; formation of channels; ratio of steam to air; rate of burning; preheating of air blast; tar removal, gas cleaning, etc. It is desirable in gas producer work that the amount of gas produced be made to vary with the demands upon the plant, but unless care is used, sudden and excessive load variations will give some difficulty, especially if the change be from light load to full or over load. The producer operating satisfactorily at light load cannot adjust itself instantaneously in the matter of temperature and rate of burning necessary to produce the quantity and quality of gas required by the increased load.

The quality of the gas is sometimes influenced to a marked extent by the nature of the distribution of the entering blast. If the air and steam are not uniformly distributed over the full area of the bed, there is a tendency for channels to form and for wide variations to exist in the temperature at different points in the same level of the fuel bed—a condition detrimental to the best results.

The proper depth of fuel bed depends very much on the character of the coal and the rate of burning. If the bed is too thin, there is a tendency for channels or holes to form suddenly; the bed is likely to become highly heated and there is usually an excess of carbon dioxide due to the lack of a sufficient fuel thickness to form a satisfactory reducing zone. Sometimes if the fuel bed is too thick, it tends to pack together to

such an extent that a uniform distribution of the blast is practically impossible.

When producer gas is used for metallurgical work and other heating purposes on a large scale the tarry products as well as the dust and ash which may be carried along in the gas, in no way interfere with satisfactory operation and on the other hand the tar vapors add materially to the heat producing qualities of the gas. Under these conditions also, the gas enters the furnace at a high temperature and the sensible heat of the gas is thus a further aid in maintaining high temperature and in producing the high efficiencies obtained from such operation.

If, however, the gas is to be used in gas engines, or in small heating appliances with gas connections which may easily become clogged, or is to be conveyed some distance through pipe lines, it is necessary that the gas be thoroughly cleaned or scrubbed and cooled, and, if tar compounds are found, that all such be condensed and removed. A small amount of tar in the gas causes considerable trouble by clogging up the passages and sticking engine governors and valves.

Gas of some kind and quality can be made from almost anything that will burn, but from the standpoint of practical convenience, the fuels commercially employed for making producer gas are generally coal, coke, charcoal, lignite and peat. In some localities wood and sawdust have been used to advantage in generating producer gas.

In the utilization of producer gas its application up to the present time has been confined very largely to metallurgical operations, or to large heating furnaces and to gas engines for the development of power. In the manufacture of iron and steel its use has been eminently successful, and in this field it has been employed for a longer period of time than in any other. In the Pittsburgh district, where the steel mills have had an abundance of natural gas, there are already in operation many large batteries of gas producers. One of the steel companies reports that when natural gas costs above eight cents per thousand, it is more economical to install and operate gas producers; the price allowed for coal on this basis was not stated.

Producer gas for power purposes has been utilized for a much shorter period. Prior to 1900 there were but very few producer gas power plants in the United States, but since that date a large number of installations have been made. Many of these are giving excellent satisfaction while many others have experienced difficulties and a few have been failures.

In the operation of producer gas power plants, the personal element has been and still is a factor of no little importance to consider. A given plant in the hands of one man will give excellent service, while the same plant in the hands of a second man may give very unsatisfactory service. This may perhaps be best illustrated by a little personal experience of the writer's not long ago. A producer gas power plant was visited with the view of obtaining information concerning the operation of the
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plant. The superintendent, who was first interviewed, said he knew nothing of the details of operating the plant, but that his engineer would willingly give any information desired. He then stated that the only things he could say were that the power never failed them, that the coal cost amounted to less than half of what it formerly did for steam, and that in fifteen months it had been running, there had been no repair bills. After a few minutes talk with the engineer, it was very evident that he had a thorough knowledge of the principles involved in the operation of both the producer and the engine, and that he took a pride in the service he was able to render. Soon after, a second plant of the same type and size was visited for the same purpose. In this case the owner was interviewed and he expressed grave doubts as to the practicability of producer gas for power; he had been able to get only intermittent service; it was so unreliable that a motor had been installed and whenever the engine refused to go he purchased electric current from a neighbor. At the time of this visit the plant happened to be in operation and upon stepping into the engine room the evident need for adjustment of the moving parts of the engine was quite alarming, and I ventured to suggest that if the play in the connecting rods were taken up the engine would probably run much smoother, to which he immediately exclaimed: "Oh, no! no! no!—if it runs at all we don't touch it."

The two cases just cited represent two extremes in power plant management. Of course the latter case is unusual and marks the lower limit of the scale and is an exhibition of a lack of common sense in such matters. I do not care to refer to the former case as the upper limit, but rather as an example of what the operation of the average plant should be. Some years ago a small company installed a plant to furnish power and light. From the start the service was rather unsatisfactory. The power was not always available and the lights would go out at the most inopportune times; the modern up-to-date power plant came to be pretty much of a joke; in desperation the company sought to make good their promises. Finally a capable producer gas man was secured and the plant was turned over to him. He worked hard and long, days and nights, making adjustments and training his crew; conditions began to improve and finally after he had learned to place confidence in the operation of his plant he granted himself an evening off for the theater. He was very comfortably seated and was enjoying to the utmost the prospect of a pleasant evening when suddenly the lights went out. He rushed out of the building and down to the power house before he realized that the lights had simply been turned off for the first act. A man with a spirit of this kind coupled with real ability will make almost any kind of a plant go. However, they are an exception and until an intimate knowledge of gas power plants becomes more general so that with each new installation a competent operating engineer may be available without resorting to the practice of breaking in a new man to run

the plant, the human element is bound to be a considerable factor. This state of affairs, however, is unavoidable and is a condition that takes time to overcome; when we consider the rapidity with which this new power is coming into being, it is not surprising that now and then an operator is having his troubles. It is not to be inferred that the personal element will finally be overcome and may be eliminated, neither are all irregularities in the operation of producer gas plants, due to inability or incompetence on the part of the operator. Many times a failure is an inherent characteristic of the apparatus itself; there is yet ample opportunity for improvement. No installation is perfect, but many of them work, and work well.

Soon after the introduction of the producer gas power plant, it was realized that rather unusual fuel economies could be obtained as compared with the usual results from steam plants, and on a wave of enthusiasm, numerous predictions were made that gas power would soon replace steam, but that has not taken place and there is no reason to believe that it ever will.

The development of the steam turbine very nearly paralleled that of the producer gas power plant and for large units in central station work it will unquestionably hold its place and with an economy very closely approximating that of gas power. It has also been said that with the advent of gas power and steam turbines, the days of reciprocating engines were numbered, but it is firmly believed that each has an ample field in which to grow and develop.

The position of the gas producer in the manufacture of steel is pretty well fixed, and in the future its application can only be increased and extended to all large heating furnaces.

At the present time the increased cost of natural gas and fuel oil has created a demand for some substitute for these fuels in small heating furnaces, and it is from producer gas that a solution of the problem is expected. In work of this character very little has been done with producer gas and information along this line is very difficult to get, or is entirely lacking. For the supply of such furnaces it will be necessary to cool and clean the gas in order to avoid any clogging in the gas distributing system; the sensible heat of the gas as it leaves the producer will thus be lost and any tar compounds that it may contain and which are high in heat value will also be lost. It is said that with an average gas thus cleaned and cooled and burned in a small heating furnace temperatures of 1,700 to 1,800 degrees F. are readily obtained, and in work requiring no higher temperature there is no reason for serious difficulty. A very few installations have been made where temperature requirements are not high, such as tempering, case hardening and heating soldering irons, and in these instances very satisfactory results are reported. But in furnaces requiring higher temperatures, such as welding heats, small crucible furnaces and heating material for bolt and rivet machines, the situation is uncertain; little is known, but the experimental stage of this development is well started.

Reports from abroad on this phase of producer gas utilization are very indefinite. So far as is known to the writer, there is but one plant in the United States where an attempt is being made to utilize producer gas for heating small crucible furnaces. Clean cold gas of about 120 B. t. u. per cubic foot is used; the gas and air for combustion are preheated by means of the waste gases to about 600 degrees F., each furnace contains a crucible holding about 200 pounds of brass. Reports already received indicate that very satisfactory results have been obtained; it is stated that the heat is ample for the purpose and that it is uniform. If continued tests confirm the results as reported, the outlook is bright for the application of producer gas to this type of heating furnace.

In applying producer gas to new uses and more particularly when it is to be used as a substitute for such a fuel as natural gas, we must keep in mind the great difference in the composition and heat value per unit volume of these two gases. Quite recently a man made inquiry concerning the feasibility of substituting producer gas for his failing supply of natural gas in a factory where there were several long lines of small gas pipe. He was very much surprised and disappointed to learn that none of his piping was large enough for producer gas.

In burning 1,000 cubic feet of natural gas, approximately 1,000,000 heat units are developed, and this combustion requires about 10,000 cubic feet of air, thus making 11,000 cubic feet of gases which enter into the burning process; and of this about 8,000 cubic feet are inert gases or diluents which cannot be avoided and which absorb heat.

With producer gas, of say 125 heat units per cubic foot, it will require 8,000 cubic feet to yield 1,000,000 heat units; approximately 8,000 cubic feet of air will be required for its combustion, making in this case 16,000 cubic feet which enter into the burning process and of which over 11,000 cubic feet are diluents.

With natural gas, the evolution of 1,000,000 heat units involves the heating of 11,000 cubic feet of gases, with producer gas the evolution of 1,000,000 heat units involves the heating of 16,000 cubic feet, and the volumes of gas for each case are as one to eight.

If we measure the world's industrial development by the consumption of fuel, it is readily seen that we are progressing at a very rapid rate, and as a period in the lifetime of a nation we have been using mineral fuel a very short time, and we have learned but little about it.

The first fuel consumed was used in a very crude way and most of the heat was lost. Although at the present time we are beginning to realize the desirability of more economic utilization, we are still very wasteful.

In the efforts of the future to conserve the fuel resources and to utilize waste materials the gas producer is destined to play an important part, and it is the firm belief that it is now enter-

ing upon a period of healthy and steady growth in its application to industrial pursuits.

Fig. 1 gives a section of a gas producer, showing the different zones. The grate is shown near the bottom upon which rests the

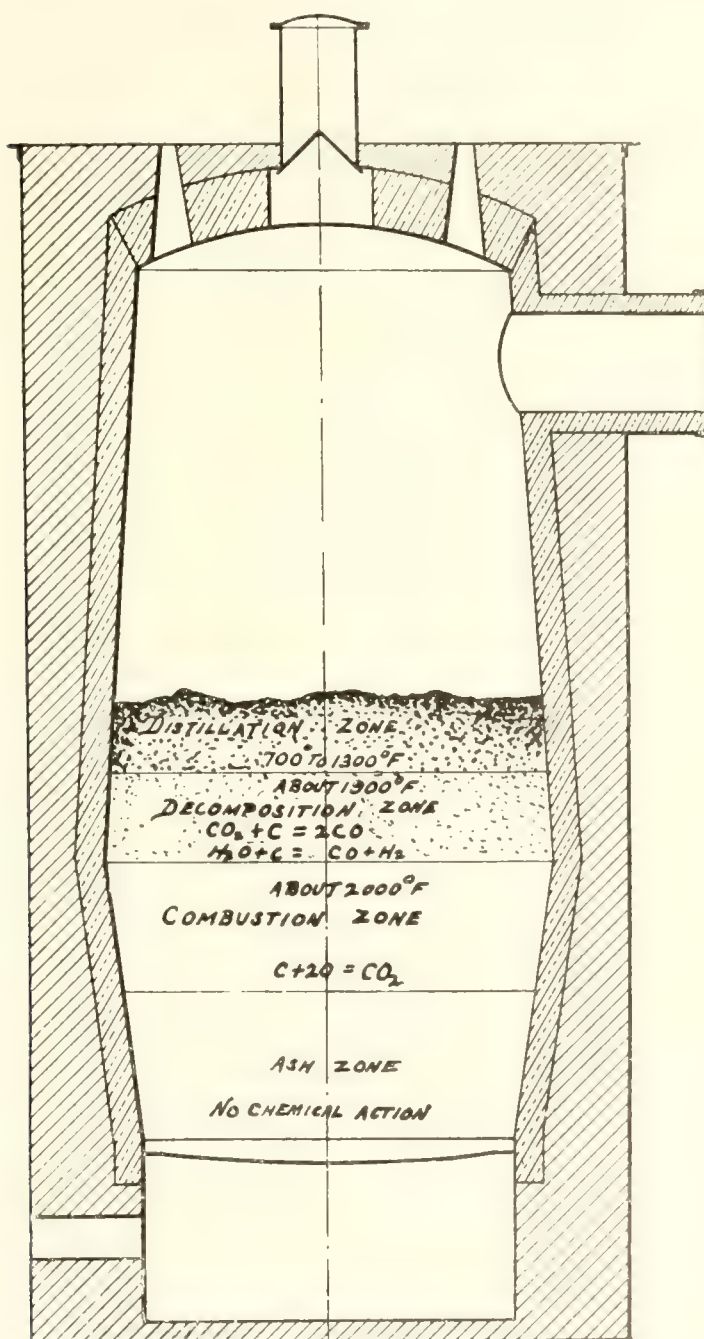
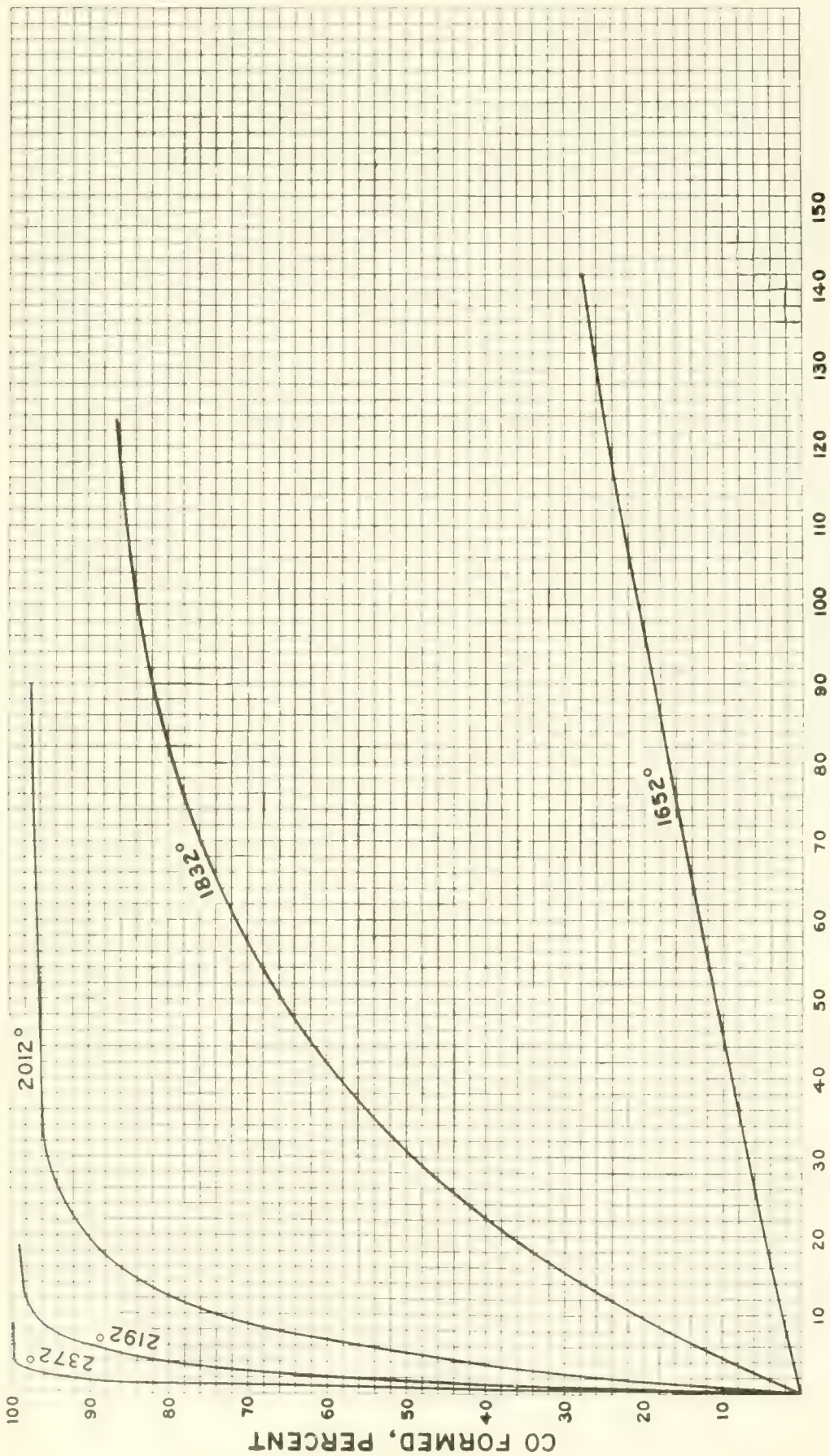


FIG 1—DIAGRAM SHOWING ZONES OF A
GAS PRODUCER

ash bed. Above this is the combustion zone where the highest temperatures are produced. Above the combustion zone is the decomposition zone which becomes highly heated from the burning of the fuel in the combustion zone, and it is in this zone that the carbon dioxide is reduced to CO. It is also here that the steam



TIME OF CONTACT IN SECONDS

FIG. 2 CURVES SHOWING VARIATION, AT DIFFERENT TEMPERATURES, OF PERCENTAGE OF CO FORMED FROM CO₂ AND COKE WITH CHANGE OF TIME OF CONTACT

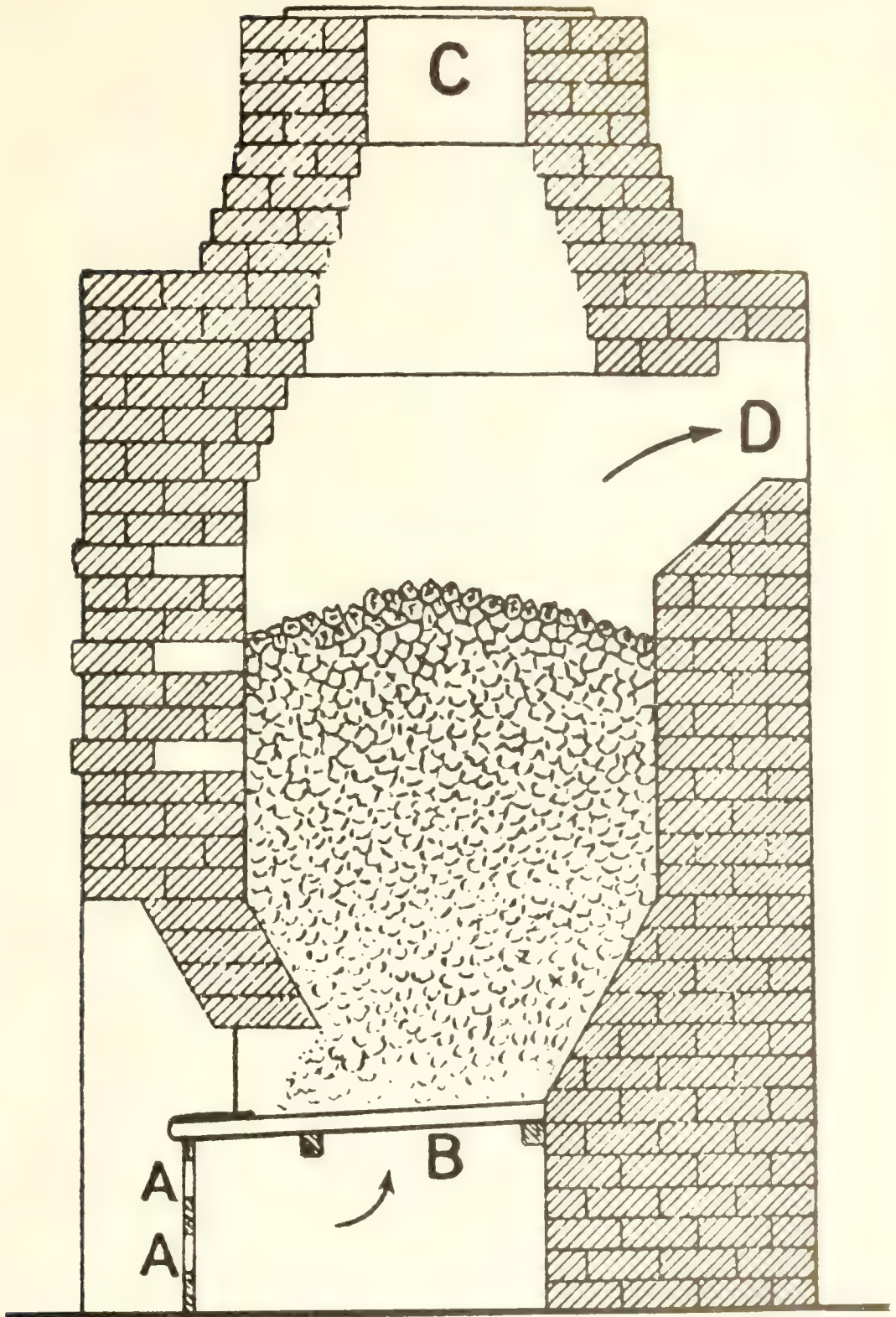


FIG. 3—VERTICAL SECTION OF BISCHOF GAS PRODUCER

or water vapor which enters with the blast is decomposed. Above the decomposition zone is the distillation zone in which the volatile matter of the coal is driven off. The gas outlet of the producer is shown at the point "A", and the openings at the top show the

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poke or peek holes. The coal hopper is here shown at the top. The blast enters the ash pit as indicated at the base.

Fig. 2. These curves show to better advantage what I referred to in the paper. Carbon dioxide in passing through incandescent coke decomposes, and a quantity of CO is formed, depending upon the time of contact and the temperature. For example,

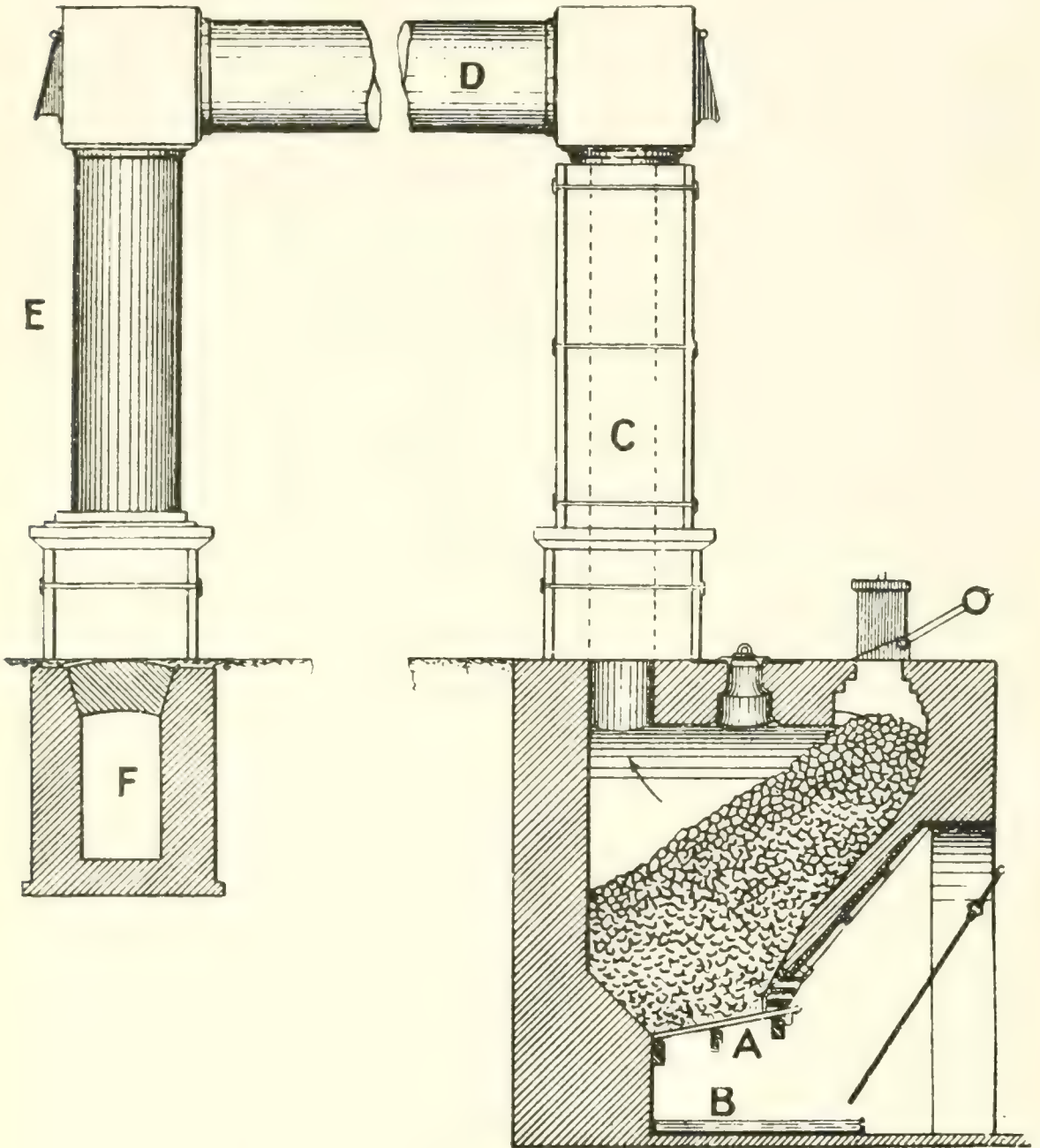


FIG. 4--VERTICAL SECTION OF SIEMENS GAS PRODUCER

in the curve showing a temperature of 1,652 degrees F., we can readily see that for a time contact of 120 seconds or two minutes, the percentage of CO formed is approximately 25 per cent, while the curve showing a temperature of 1,832 degrees F., the time contact of only one minute shows a percentage of CO of over

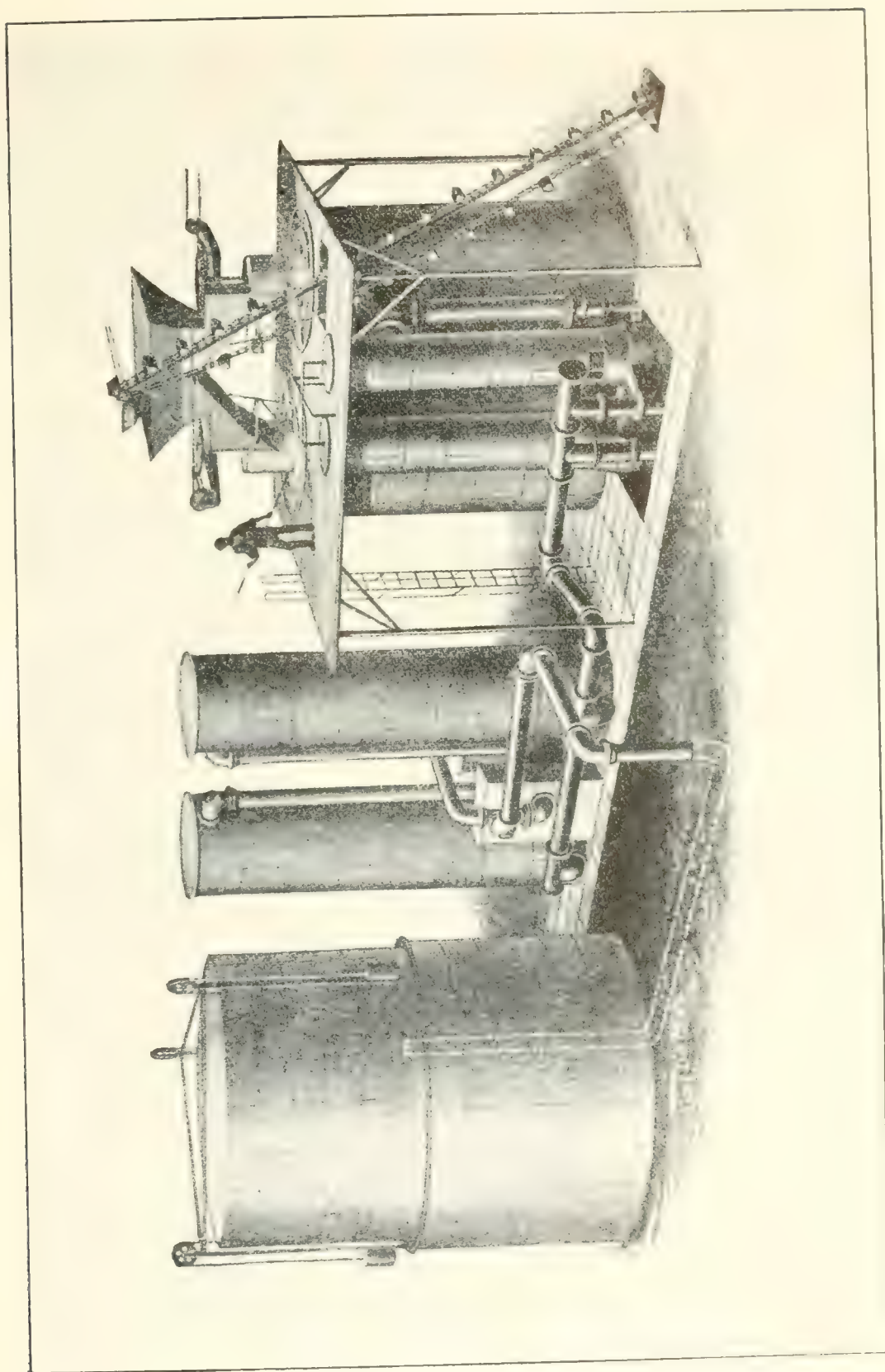


FIG. 2. ARRANGEMENT OF GAS PRODUCER PLANT WITH GAS HOLDERS

70 per cent. With the curve showing a temperature of over 2,000 degrees, a CO content of over 90 per cent is secured in less than 25 seconds, and with a temperature of 2,370 degrees, it is seen that the decomposition of CO takes place very rapidly and is practically completed in about two seconds.

Fig. 3 shows the Bischof gas producer—one of the first made.

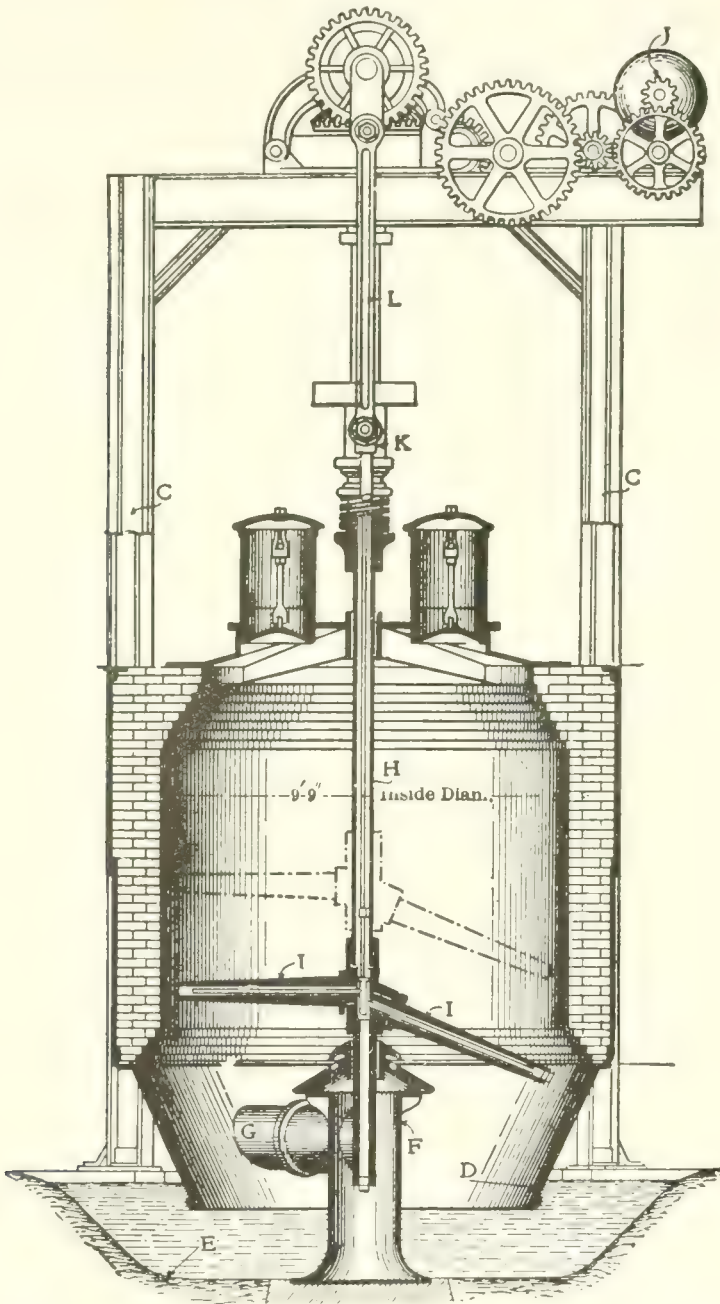


FIG. 6. SECTION OF FRAZER-TALBOT GAS PRODUCER

It does not differ fundamentally from the producers used at the present time. We have the thick fuel bed as here indicated with the grate "B", gas outlet "D", and charging hopper "C". The opening provides for the removal of clinker and ash. Air and steam enter the ash pit beneath the grate, as shown by the openings "AA".

Fig. 4 shows the original Siemens gas producer, which was the first producer that was successful on a commercial scale. The coal was charged through the hopper, passed downward over the inclined wall to the grate "A", through which passed the air and steam necessary to burn the fuel. The gas produced passed up-

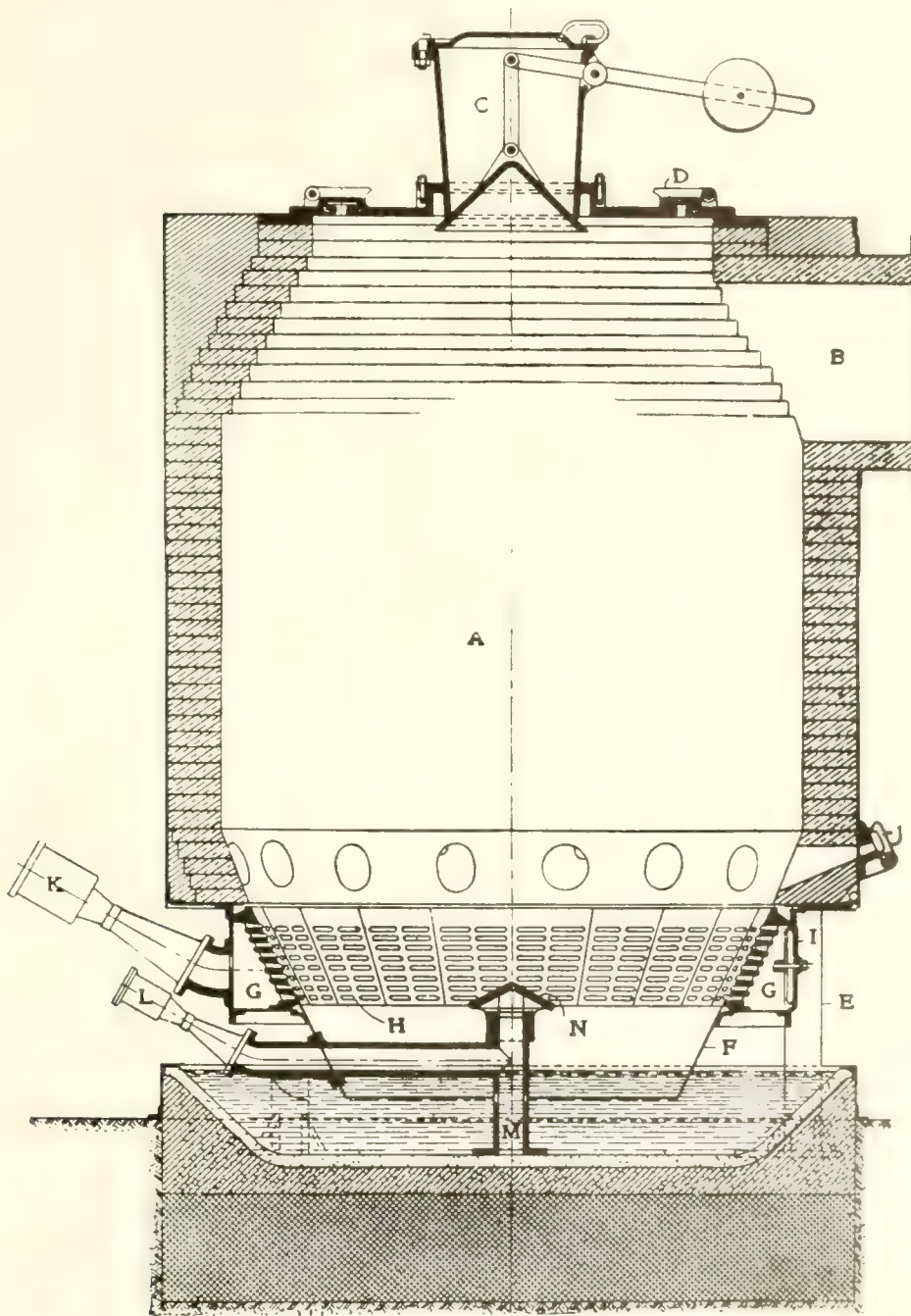


FIG. 7—SECTION OF GAS PRODUCER
(FORTER-MILLER)

ward through the pipe "C" and through the connections, as shown, to the large gas tunnel "F", through which it was conveyed to the points desired. The fuel bed was observed and also stirred when necessary through the opening shown in the top of the producer.

Fig. 5 shows a complete gas producer outfit for using anthra-
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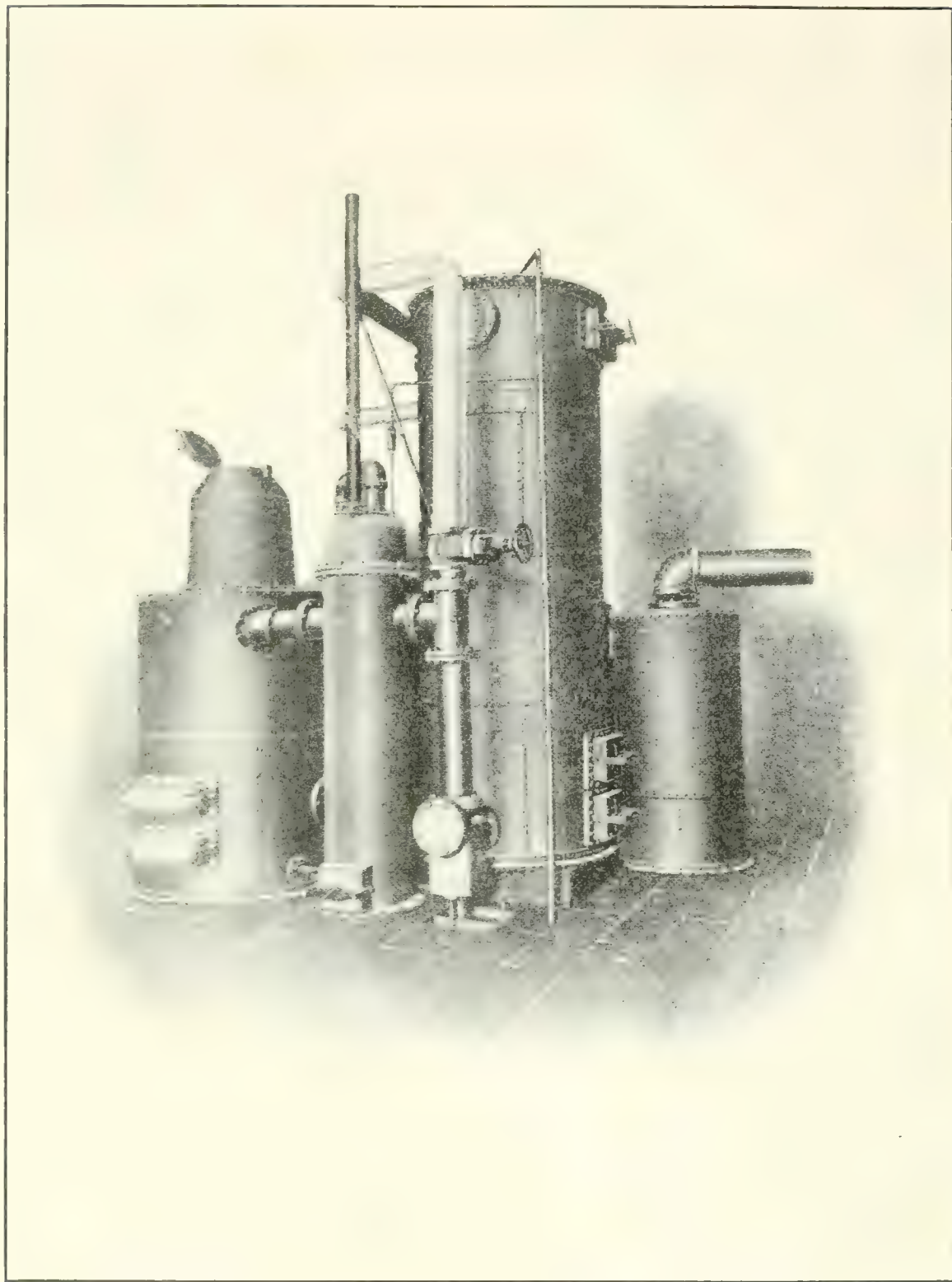


FIG 8—OTTO SUCTION GAS PRODUCER

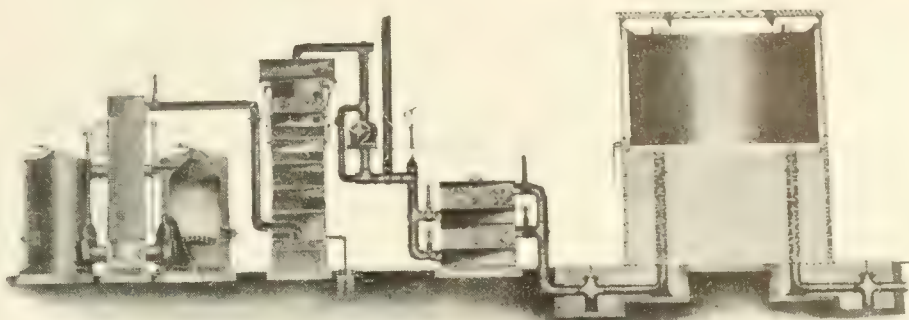


FIG 9—SECTIONAL VIEW OF LOOMIS-PETTIBONE GAS GENERATING SYSTEM

cite coal. The fuel is conveyed to the operating floor, as shown, and is then charged into the producer through the coal hoppers on either side. The gas leaves the producers near the top, then passes downward and through pipe connections to tall coke scrubbers, which are continually sprayed with water and in which the gas is thoroughly cooled as it passes upward. From the scrubber the gas leaves near the top, then passes downward through the pipe indicated and into the gas holder, as shown at the left of the view. From the holder it may be conveyed by pipe to engines or furnaces as desired.

Fig. 6 illustrates a mechanically stoked type of producer. The fuel is charged through the hoppers, as shown at the top, in the usual manner. Air blast enters from beneath through the blast pipe, as shown. The central shaft shows the fuel stirring or

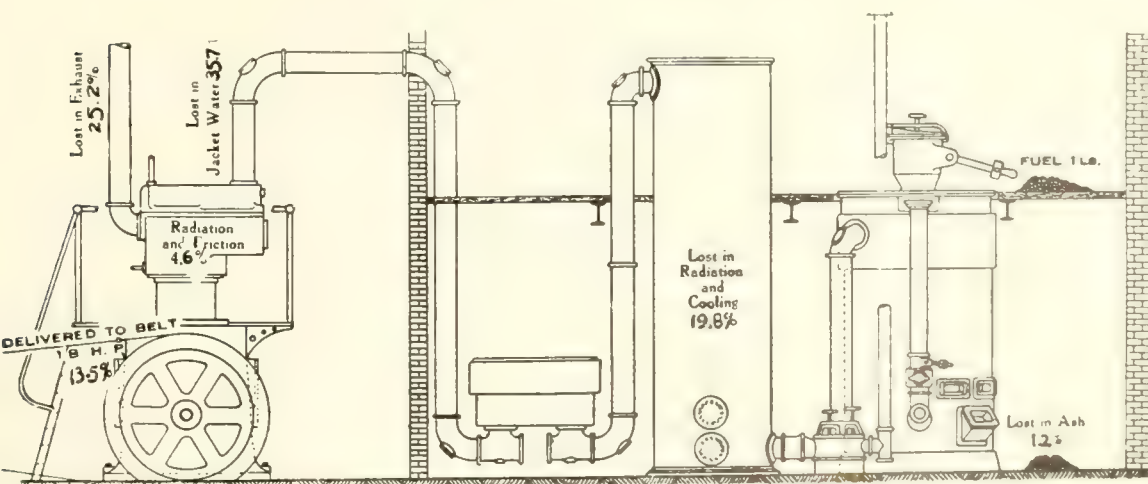


FIG 10—SECTION OF GAS PRODUCER POWER PLANT

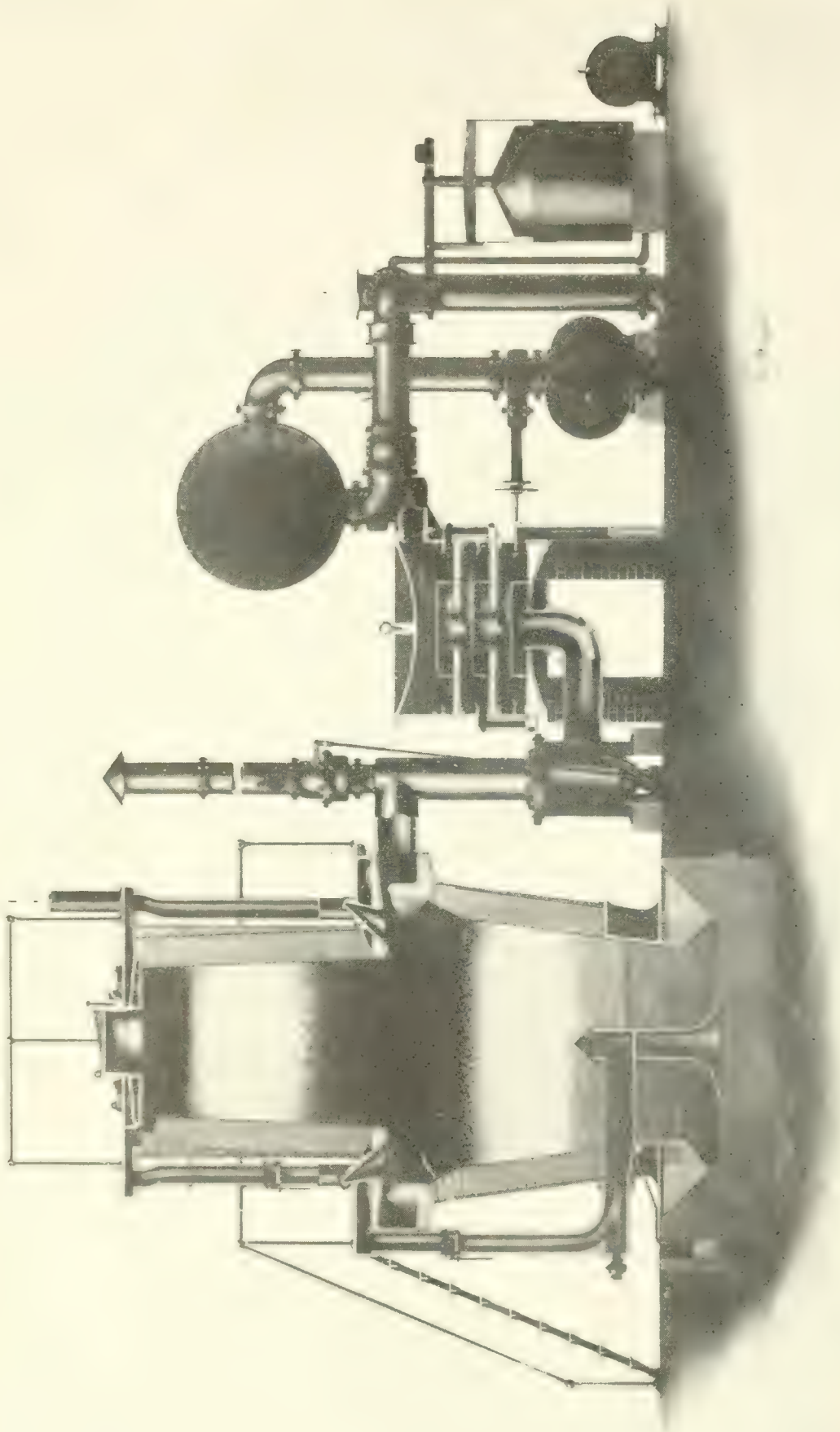


FIG. 11. Double-Acting Vertical Steam Engine, Machine Company's Type T. Bituminous 125 H. P. Half-Tone Section

agitating device, which is operated by the series of gears shown above the producer. Its arrangement is such that as it revolves it rises and falls through the fuel bed, as indicated by the dotted lines. Its function is to prevent the formation of blow holes and consequently to prevent low heat value gas, as well as to avoid large clinker accumulation. The apparatus, working as it does in the hot fuel bed, is of necessity water-cooled. Ashes are removed from the bottom through a water seal, as is here plainly shown.

Fig. 7 gives another style of producer of a general type. The circular openings shown around the outside of the producer provide a means for examining the fuel bed at any point and also for barring clinkers and for poking the fuel bed. One characteristic of this producer is the method of distributing the air

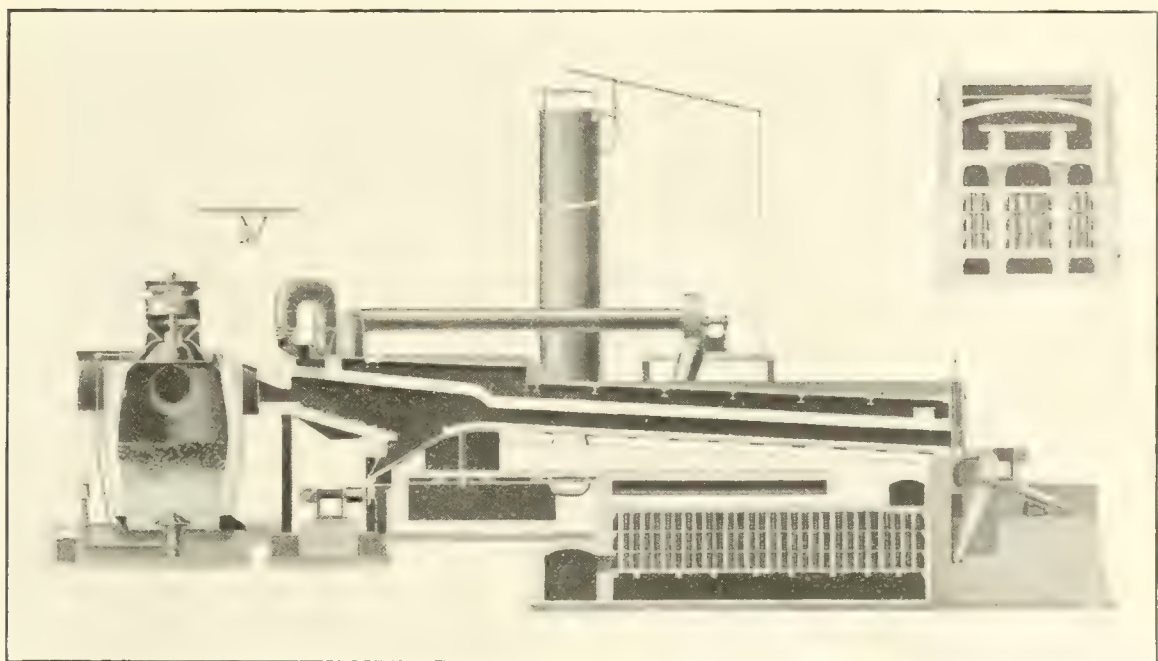


FIG 12—MORGAN CONTINUOUS GAS PRODUCER IN CONNECTION WITH BILLER HEATING FURNACE

blast. It is readily seen to be more complex than any of the previous producers. Air enters through the central blast pipe, as shown, and also through a separate opening into an annular space, as shown at "G". From this space it enters the fuel bed through numerous tuyeres, as indicated. The gas outlet at "B" is the same as in any other producer, as is the charging device and poke holes at the top.

Fig. 8 illustrates a typical suction gas producer. The whole system is under suction from the action of the engine, which draws in a charge during its suction stroke by virtue of its own energy. Coal is charged through a double-sealed hopper to avoid admission of air with the coal. Air is drawn in at the bottom, the gas leaves near the top and passes through a vaporizer or a small heater which supplies vapor to the air blast. From the

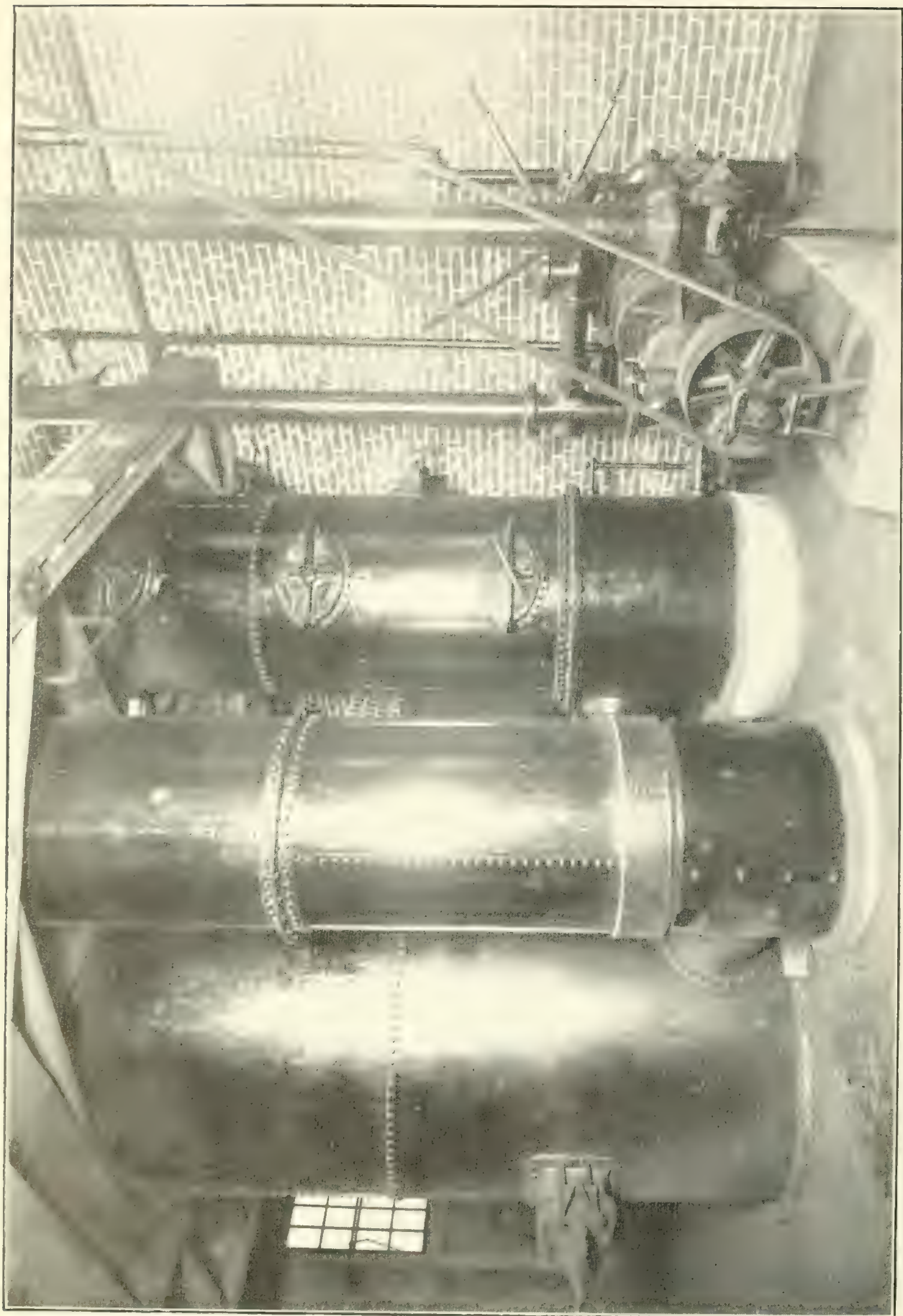


FIG. 13—GAS PRODUCER—INSIDE VIEW



FIG. 14—DEAF GAUGES ON GAS PRODUCER

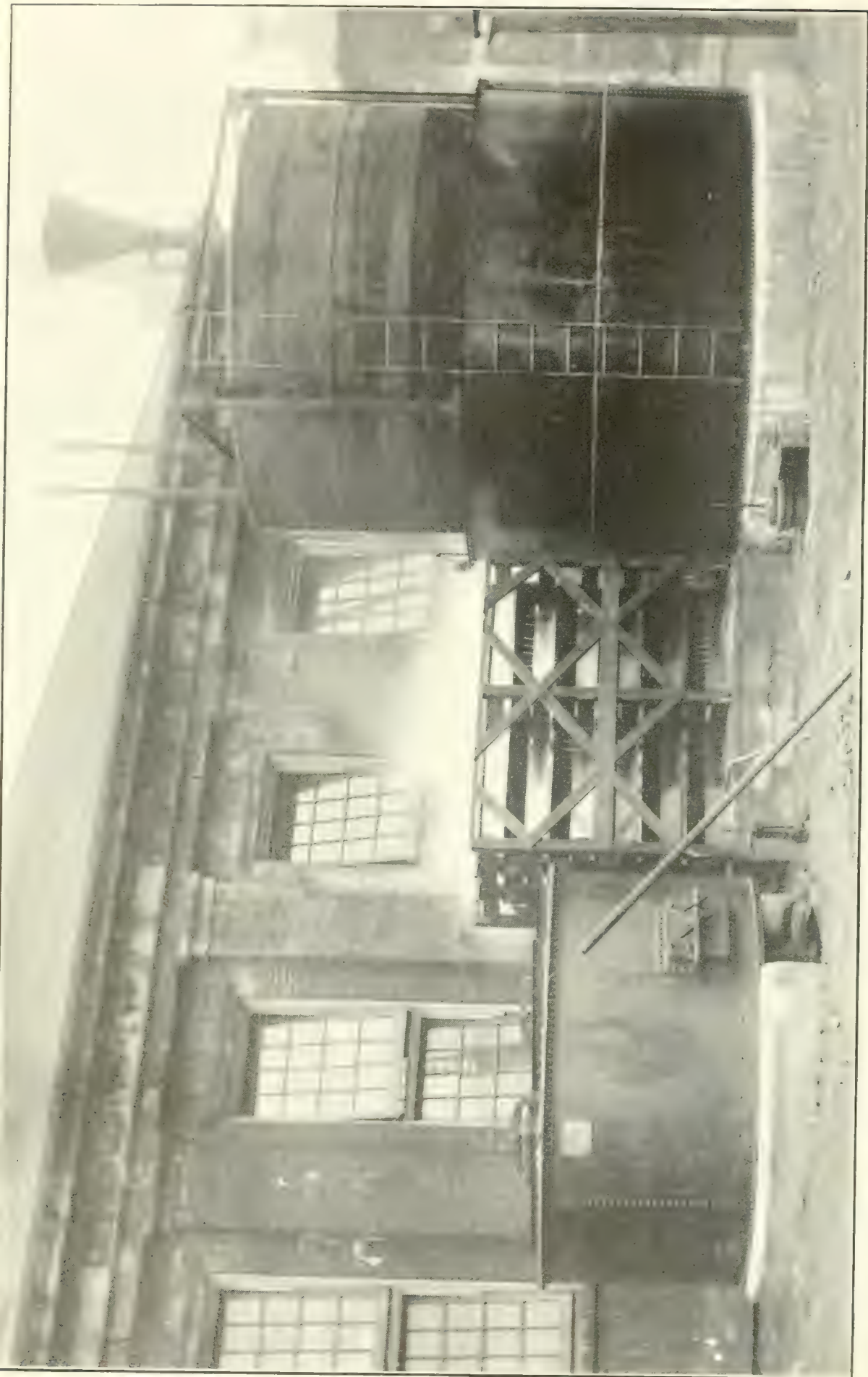


FIG. 15. GAS PRODUCER (OUTSIDER VIEW) SHOWING WET SCRUBBER, COOLING TOWER AND GAS HOLDER

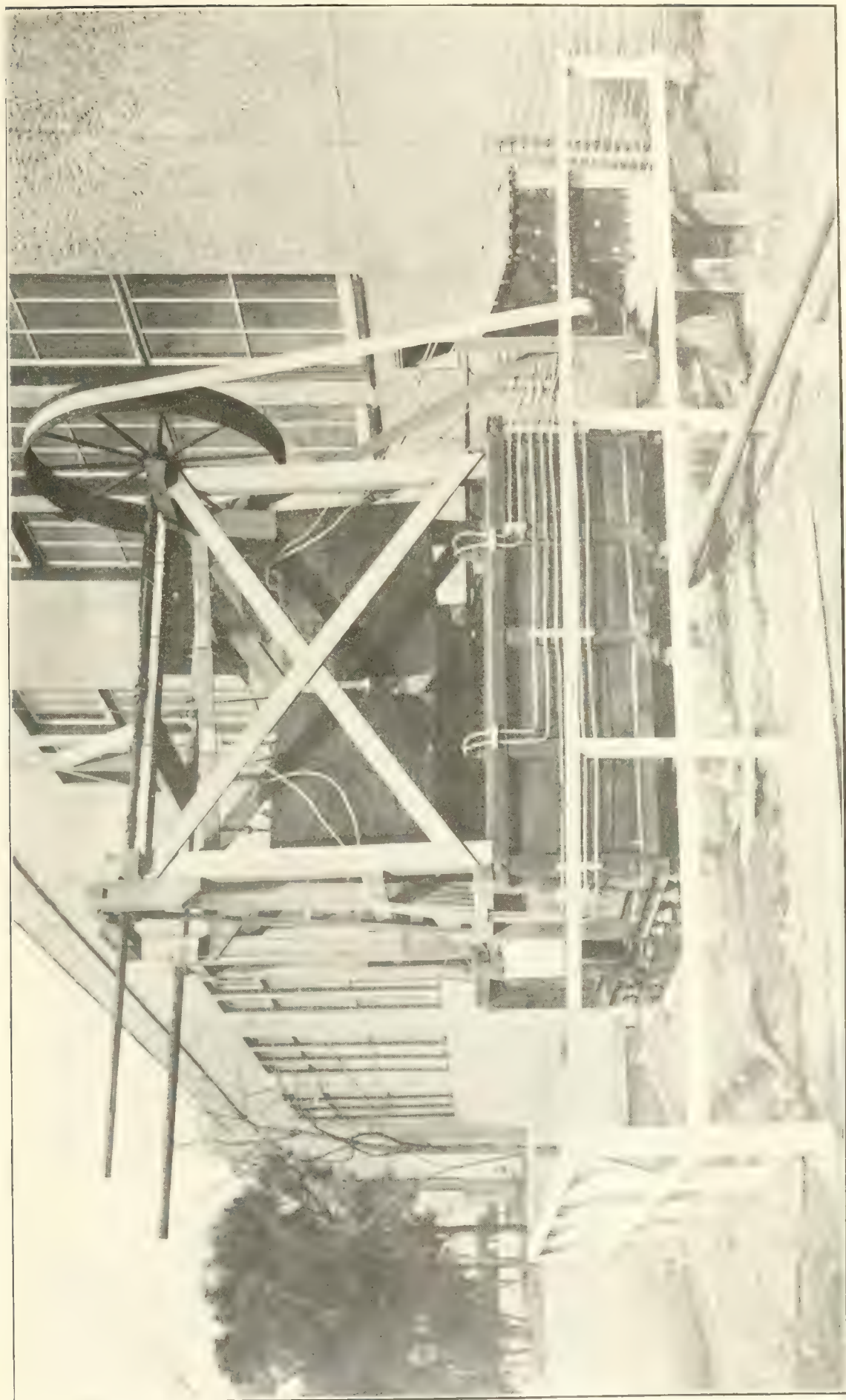


Fig. 16 Water Wheel for Displaying Electrical Energy—Norkon Plant.

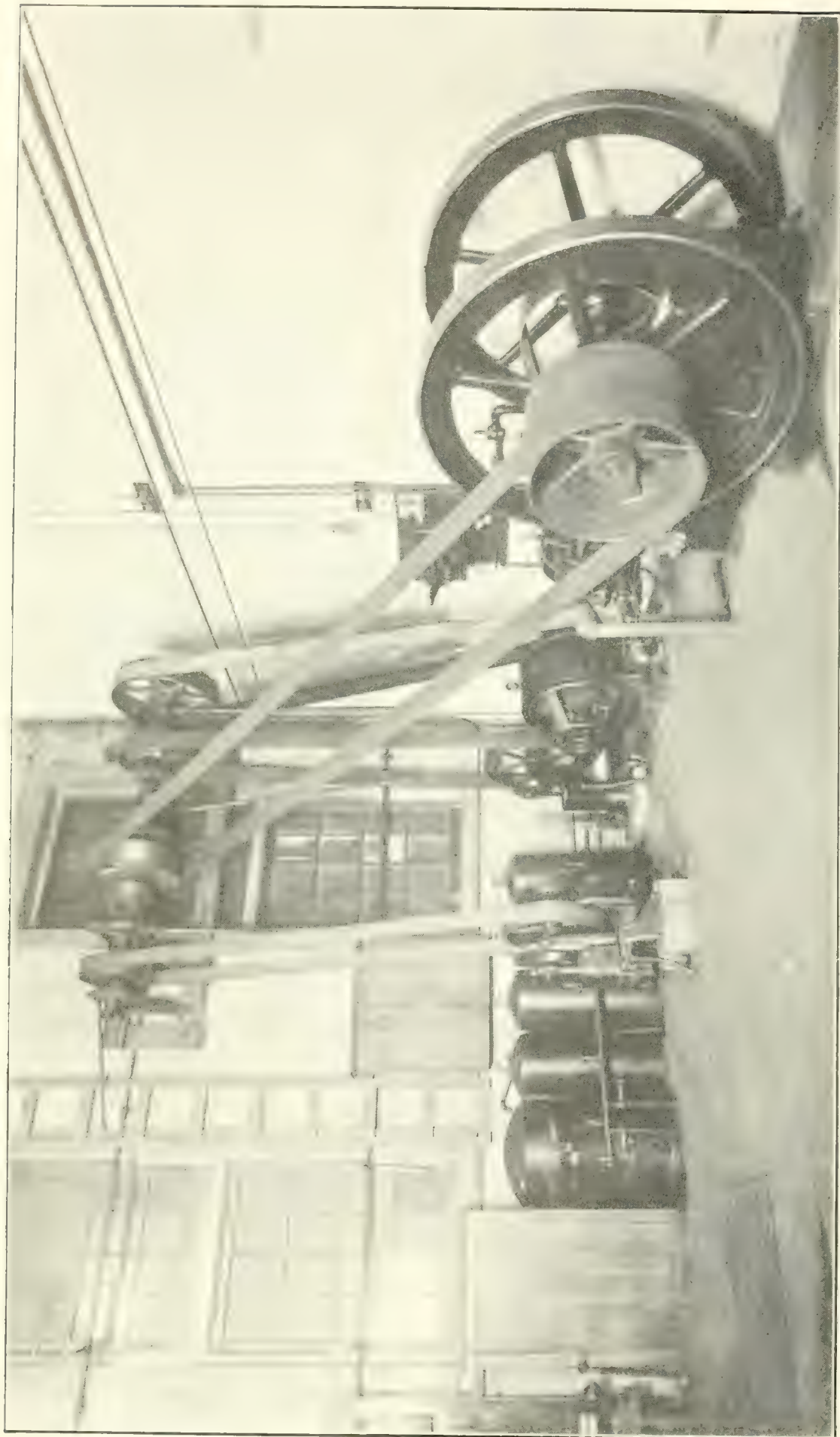


FIG 17—AUXILIARY APPARATUS FOR GAS PRODUCER

vaporizer the gas is passed through an ordinary coke scrubber to the receiver, from which the gas is piped directly to the engine.

Fig. 9 is an illustration of a typical downdraft producer, consisting of two generators which are connected to a boiler, together with wet scrubber, exhauster, dry scrubber and gas holder. In the operation of this plant usually two types of gas are produced, namely, air gas and water gas. In the normal operation of the plant, fuel is charged at the top through openings, as shown; air is also drawn in at the top, passes downward through the deep fuel bed and out through the connections shown at the base of the boiler. After operating upon air for a few minutes, the period varying with the conditions under which the plant is working, the fuel bed becomes highly heated. The air is then temporarily shut off and steam is blown through, thus producing water-gas. While water-gas is being formed the gas is usually connected to a separate holder. This process is repeated at frequent intervals and alternately with the generators. This plant makes, as is seen, two

Analysis of Producer Gas.

Fuel.	Penn. No. 7.	Penn. No 10.	N. D. No. 2.	Illinois No. 110.	W. Va. J.7
CO ₂	10.2	9.2	8.7	12.2	6.0
O ₂	0.0	0.0	0.2	0.1	0.0
CO	17.5	20.4	20.9	12.6	25.5
H ₂	11.3	13.8	14.3	9.5	15.8
CH ₄	2.5	3.4	4.9	3.5	1.8
C ₂ H ₄	0.0	0.0	0.0	0.0	0.0
N ₂	58.5	53.2	51.0	62.1	50.9
B. t. u.....	139.4	159.5	188.5	109.8	160.0

FIG 18—TABLE SHOWING TYPICAL PRODUCER GAS ANALYSES

kinds of gas which vary considerably in heat value, the air gas being approximately 110 heat units per cubic foot, while the water gas will run about 275 heat units per cubic foot. These may be used separately if so desired, or they may be mixed and used as ordinary producer gas.

Fig. 10 shows the economy obtained from a producer gas power outfit, and exhibits graphically some of the losses that take place between the coal pile on the producer charging floor, and the power delivered by the engine fly-wheel. The first loss indicated is that of 1.2 per cent in the ash. In the scrubber there is a loss of 19.8 per cent, due to cooling and radiation. In the engine the jacket water loss is given as 35.72 per cent, radiation and friction losses, 4.6 per cent, and in the exhaust, 25.2 per cent. This leaves a total of 13.5 per cent as available energy in the engine fly-wheel, and is a figure readily realized by comparatively small units, and which can hardly be equalled by steam plants of the same sizes.

Fig. 11 is a view of a double zone gas producer. All of the fuel is charged at the top through the opening indicated. Air and

steam for combustion enter at the top through pipes, and also through the central blast pipe located in the ash pit. Combustion takes place both above and below and the products of combustion pass upward and downward toward the center of the producer and out into an annular space, as shown, which is connected to the pipes leading away from the producer. Around the annular gas outlet is another annular receptacle, which holds hot water. The air blast is passed over the surface of this hot water and in so doing it picks up the necessary moisture for the air blast. This type of producer operates under a suction produced by an exhaustor. In passing from the producer to the exhaustor the gas enters a scrubber, which takes out much of the dirt and lamp-black. The particular function of a double zone producer is the production of a tar-free gas. This is accomplished in the upper zone, in which the volatile matter from freshly fired coal passes through the incandescent bed to the gas outlet and becomes fixed

Results From High Ash Coals.

Fuel.	Moisture per cent.	Ash per cent.	Pounds of fuel consumed in producer per B. H. P. hour.
Mass. Peat.....	32.64	11.42	2.27
Illinois	11.47	16.08	1.61
Virginia	3.34	18.14	1.13
New Mexico.....	3.62	19.63	1.10
Iowa	16.69	20.70	1.56
Wyoming	8.63	21.73	1.83
Brazil	10.96	23.44	2.02
West Virginia.....	2.91	28.08	1.26
West Virginia.....	0.47	43.74	1.65

FIG 19—RESULTS FROM HIGH ASH COALS, CHART SHOWING POUNDS OF FUEL CONSUMED PER B. H. P. HOUR AND PER CENT MOISTURE AND ASH

into permanent gases. In doing this, however, a considerable quantity of lamp-black is usually produced, but this is not considered by many to be a serious drawback.

Fig. 12 gives a view of a heating furnace directly connected to a Morgan continuous producer. Billets to be heated are fed into the furnace, and are gradually pushed upward through the furnace, at the other end of which they drop out by gravity, preheated for rolling or any other process desired. Air for burning the gas is preheated in a checkerwork, shown beneath the furnace, by the sensible heat of the waste gases. The air then mixes with the gas as it leaves the producer, where it burns and produces an intense heat.

Fig. 13 gives a view of the producer installed for testing purposes at the Pittsburgh station. It is a producer of the down-draft type in which the gas leaves near the bottom. It then passes upward and downward through the preheater and then enters the base of the scrubber, from which it passes upward

through several layers of coke which are continually sprayed with water. The gas exhauster which exhausts the gas from the producer and sends it under pressure through the gas holder to the engine, is also shown.

Fig. 14 is also a view of the charging floor of the producer plant, showing draft gauges which are connected by piping to the various parts of the plant. A glance at these gauges at any time indicates at once the suction or pressure, in inches of water, in any part of the gas system. The gauge shown here is merely an indicator of the height of the gas holder which is located on the outside of the building.

Fig. 15 is the dry scrubber connected with the Pittsburgh plant. This is simply a large tank through which the gas passed and which contained excelsior. It served to collect the water carried over by the gas and it also caught a large quantity of lampblack that escaped through the wet scrubber. From the dry scrubber the gas passed to the holder, and from there the gas passed

Total Pounds of Coal as Fired Per Hour Per E. H. P. Developed at The Switch Board For Steam and Producer Gas Plants.

Fuel used.	Steam.	Pro. Gas.	Ratio.
Illinois No. 19.....	4.09	1.47	2.78
Indiana No. 7.....	4.39	1.65	2.66
Iowa No. 2.....	5.82	2.07	2.81
Missouri No. 2.....	5.44	1.94	2.80
North Dakota No. 1.....	10.09	2.82	3.87
Ohio No. 6.....	4.00	1.30	3.08
Pennsylvania No. 10.....	3.55	1.32	2.69
Virginia No. 3.....	3.57	1.21	2.95
West Virginia No. 14.....	3.41	1.10	3.10
Wyoming No. 2.....	6.64	2.28	2.91

FIG 20—TABLE SHOWING COMPARATIVE POWER PLANT ECONOMICS

through a meter to the engine. Between the holder and the dry scrubber may be seen a small water-cooling tower, which was devised to cool the engine jacket water.

Fig. 16. From the beginning, in conducting the gas producer tests, it has been considered essential to maintain a full load on the engine. At no time, however, have the power requirements of the plant been equal to this load, and the balance of the power generated was, therefore, absorbed in a water rheostat, which is shown here. Electrical connection was made between the generator and rheostat, as is shown by the numerous wires. By regulating the rise and fall of a large iron plate any load desired could be maintained at the engine.

Fig. 17 gives a view of the auxiliary apparatus connected with the Pittsburgh plant. The small engine located at the right is an auxiliary used for starting up the plant. This was operated on natural gas. It was used for compressing air and gas and also drove the gas exhauster which operated the producer. After the May, 1913

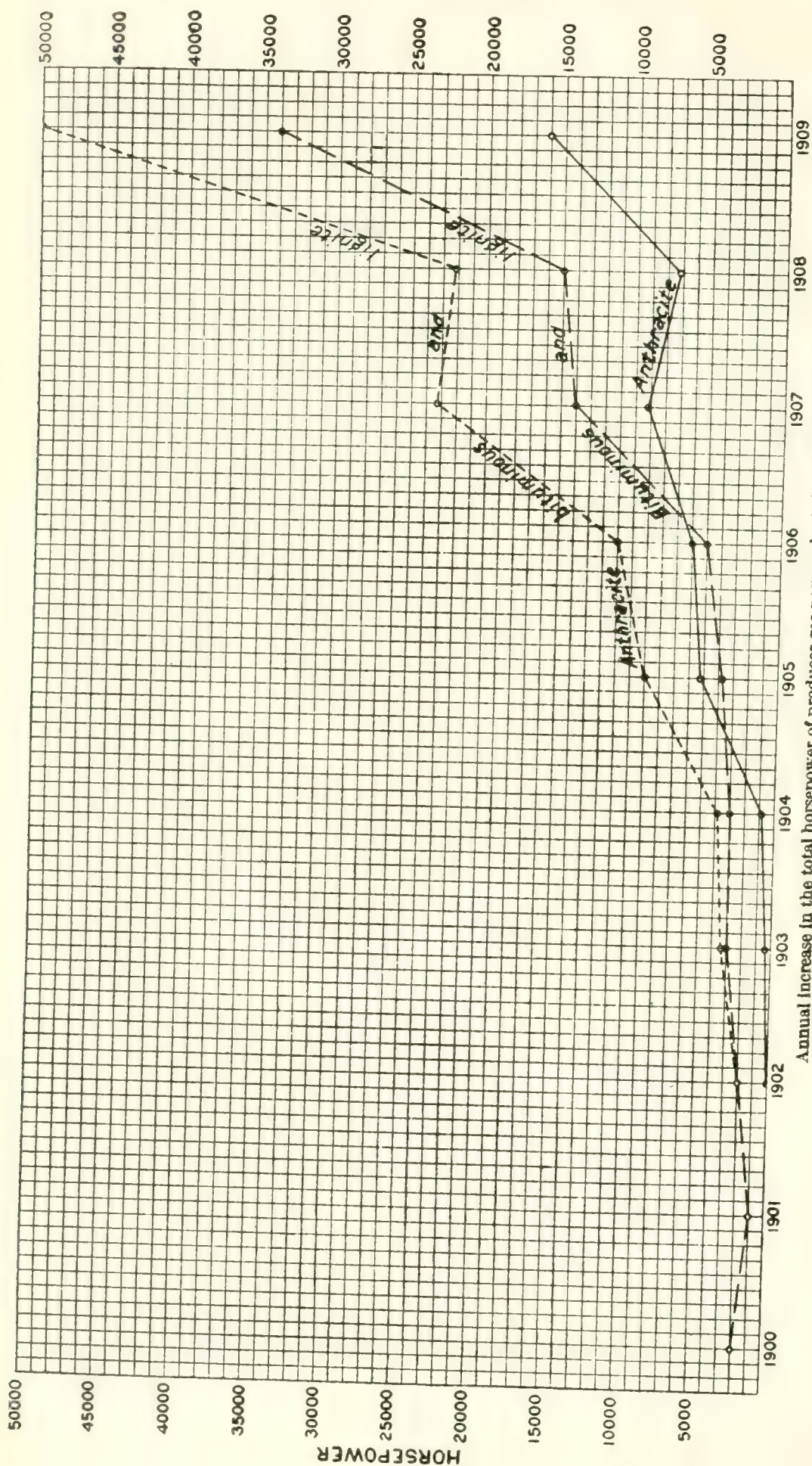


FIG. 21—CHART SHOWING ANNUAL INCREASE IN THE TOTAL HORSEPOWER OF PRODUCER-GAS POWER PLANTS IN THE UNITED STATES.

OF GAS PRODUCER POWER PLANTS IN THE U. S.

large gas engine was started and had taken the load the small engine was stopped and the motor which drove the gas exhauster was started. The four tanks are the compressed air tanks.

Fig. 18. This table gives a number of typical analyses of gas from an updraft producer. It will be observed there is a considerable variation in the analysis of gas from different fuels as well as in heat value. For example, in the fourth column the analysis is of a gas from North Dakota lignite, and it is seen to be very high in heat value; in fact, much higher than that from gas in the last column, which is from one of the best West Virginia coals. The Illinois coal is seen to give much the poorest gas. It should not be inferred, however, that this is typical of all Illinois coals. I might state in this connection that in all the coals tested at the station the lignites of North Dakota and Montana have produced a gas having the highest heat value per cubic foot of any gas made. The quantity of gas produced, however, is considerably less than that from many other fuels.

Fig. 19. This table shows the results obtained from a number of high ash coals. It is interesting to note that a fuel containing an ash content of nearly 44 per cent produced a brake h. p. hour on only 1.65 pounds. This particular fuel worked exceedingly well in the gas producer and there is no reason why it should not be used regularly in producers at the present time.

Fig. 20. This table shows a comparison of fuel consumption for steam and producer gas power plants. The first column gives the fuel per electrical h. p. developed at the switchboard for steam plants; the second column the fuel consumption for gas plants, and the third column gives the ratio of the two, which is seen to be approximately 2.8; that is, it takes 2.8 times as much coal in a steam plant as is required by a producer gas plant developing the same power. The figures are based upon the results obtained at the St. Louis testing station.

Fig. 21. These curves show the rapid growth of gas producer power plants in the United States. Unfortunately the bureau has not data available to bring the curves up to date, but they do show the rapid growth that took place soon after producer gas power was introduced. It will be noted from these curves that the anthracite producers were considerably in advance at the start but were gradually over shadowed by the bituminous and lignite plants, the increase being very rapid between the years 1906 and 1907.

Discussion

Q.—I should like to ask Mr. Smith about the high temperature producers that are operating with the slag. Can you tell us anything about recent experiments on those?

A.—We have been working along this line for the past two
May, 1913

years and have made a number of tests that have been very satisfactory. Usually the gas would run above 30 per cent CO, and at times when the conditions were good it ran as high as 33 per cent, and with the slag running very satisfactorily. Tests have been made of 100 hours duration in which the slag was tapped off every hour without difficulty. There has been some trouble with the lining of the producer burning out due to the extremely high temperatures produced, and at the present time an attempt is being made to overcome this by introducing water-cooling. This, apparently, has been overdone, for the slag has been chilled to such an extent that it would not run freely from the producer. The result, however, is very promising and I see no reason, when some of these difficulties are overcome, why it will not prove satisfactory. There are two pretty good reasons for producers of this kind. The first is the disposal of ash by melting it into a liquid when it can readily be tapped off, thus avoiding difficulties due to clinker troubles and ash accumulation. The second is the more effective reduction of CO_2 to CO. CO is the chief combustible constituent of producer gas and its formation takes place most readily at very high temperatures, but in producers of the types now used any attempt to operate at high temperatures results in serious clinker difficulties and the result is, producers are operated at as high a temperature as possible for the maximum CO, but below a temperature that will cause the ash to fuse and give trouble. If we go the whole distance, operate the producer at extremely high temperatures, clinker difficulties are avoided by slagging the ash into a liquid and the conditions are ideal for a high CO content.

Q.—What influence has the slagging method on the capacity of a producer? Does it increase the capacity?

A.—It increases the capacity very much. In our work we have burned as high as 35 pounds of fuel per square foot per hour, but this is by no means our limit. A French producer of this same type makes claims for a fuel consumption of 200 pounds per square foot per hour, but whether or not these figures are correct I do not know. It looks pretty large.

Q.—I should like to ask Mr. Smith if he has any means for determining the proper amount of steam to add to the air for the pressure producer.

A.—This is one of the things we have yet to work out. We do not know. It will probably depend, however, upon the character of the coal.

Q.—I should like to ask Mr. Smith if he can tell us anything about powdered coal producers, and whether or not he considers the Smith recording calorimeter a reliable instrument.

A.—I have had no experience with powdered coal producers and have only talked with men who have worked with them. I understand that experimental work along this line is being revived and that one company is expecting to put something of this kind on the market before long. It is reported that they are looking

for great things, but are keeping pretty quiet at the present time. That is all I can say about powdered coal producers.

In regard to the recording calorimeter. When we first installed one we had some trouble with it, which we found to be our own fault more than anything else. The instrument has checked up very closely with the heat value determined from analysis and it always shows up little fluctuations in the heat value of the gas that an analysis will not detect.

Q.—I should like to ask Mr. Smith what would be the proper working temperature at the top of a pressure producer using ordinary bituminous coal?

A.—I do not know what the proper temperature should be. In power work that has varied over a considerable range and in the tests that we have made it has varied from 700 (and in one or two cases less) to 1,200 degrees F., and in producers used for metallurgical work it is probably more than 1,500 degrees at times. Just how that affects the efficiency of the operation I do not know.

February 11, 1913.

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Modern Explosives and Their Use

By F. H. GUNSOLUS.

General Introduction.

From the time of the invention of gun powder, or approximately in the year 1250, the problem of explosives has been a study. Today it is being studied as hard and as thoroughly by the majority of actual consumers as by the reliable manufacturer, both from a humanitarian and economic standpoint. Like many other questions of vital importance and interest to the general public, it is being studied with the idea of ascertaining how so destructive an agent when carelessly handled can be harnessed by caution and common sense into one of the greatest and most valuable agents of modern times.

With these two main points in view, the reliable manufacturer is making it a study with the idea of producing that explosive which will meet the various demands in mining, quarrying and all blasting operations, and to supply the best at a minimum cost to the consumer. As regards coal mining, he is endeavoring to produce that explosive which will be the safest to use in gaseous or dusty mines and thus be a better protection to the property of the operator and to the lives of the miners.

The consumer is making it a study with the idea of determining what kind of explosive and which explosive is better adapted for the work in hand, while the reliable manufacturer is making every effort to supply that explosive which will fill the various conditions and demands not only for the present time, but also future demands.

Before proceeding further, it might be of interest to mention some facts in connection with the history of explosives and their use as blasting agents.

History.

Gun powder was known in a crude form by the Chinese for many centuries, but according to the best information, it was first mentioned to the western world about 1310-1320 A. D., and was then used only for throwing projectiles. Not until 1629 was gun powder used as a blasting agent, when Caspar Weindl invented the use of gun powder for blasting purposes. A demonstration was made for this purpose in Schemnitz, Hungary, where it was shown conclusively that its use would materially aid in mining and quarrying operations. In 1823 a man by the name of Snow Harris first applied electricity to fire the charge of gun powder. In 1831, fuse was invented by Bickford. Up to 1854, or 227 years after the first demonstration of gun powder in

blasting operations, this was the only explosive which could be used for such purposes.

Perhaps the discovery which had the greatest influence on blasting operations was made by Ascanio Sobrero, in 1846, when he discovered nitro glycerin. Not until 1863, however, was nitro glycerin available for general use owing to its extreme sensitiveness and to the inconvenience of handling it in its liquid state. Alfred Nobel, the great Swedish chemist, at this time found that using infusorial earth, known as Kieselghur, as an absorbent for the nitro glycerin, overcame these objections to a large extent, and in 1867 he introduced this mixture under the name of dynamite. About this time Brown, a chemist in the English war office, discovered the detonating effect of exploding fulminate of mercury in the dynamite and thus its success was assured.

Gelatin dynamite was next produced, when Alfred Nobel discovered that nitro-cotton was easily dissolved in nitro glycerin, forming an explosive gelatinous mass which he called blasting gelatin.

Such was practically the state of affairs as concerns explosives up to the year 1886. It was then recognized that most explosions in coal mines were due to the ignition of fire-damp by the firing of shots, and it was also recognized that it would be possible to produce explosives which could be used in coal mines and which would considerably reduce this danger. It has only recently been proven that the coal dust in bituminous coal mines is explosive when subjected to the hot flames of an explosive of long duration, such as blasting powder.

From 1886, the strides made in the investigations, inventions and productions of different kinds of explosives have been very rapid. In fact, all explosive manufacturers produce two or three of the several kinds of explosives; straight (or in other words, nitro glycerin dynamite), gelatin, extra (or nitrate of ammonia nitro glycerin explosives), "permissible" explosives, low freezing dynamites, non-freezing dynamites, and detonators of different varieties. It is left, however, to the largest manufacturers of explosives to produce all of the different kinds just mentioned, and also to more thoroughly study the subject and make stable improvements.

Testing Explosives.

Before the sale of an explosive is undertaken those who manufacture and sell explosives should make such tests as will determine the characteristics of that particular explosive. Some of the points to be determined about any explosive are:

- (1) Sensitiveness.
- (2) Comparative strength.
- (3) Waterproof qualities.
- (4) Effects of temperature on the explosive.
- (5) Nature of gases resulting from detonation.

- (6) Velocity of detonation—that is, quickness.
- (7) Height and duration of flame.
- (8) Temperature of detonation.
- (9) Heat of detonation.

There are many tests which have been devised and have been and are used to determine these various characteristics of explosives as far as possible before the explosive is taken into actual work in a quarry or mine. Only those in the explosive business seem to fully realize the difficulties in the way of a proper comparison of the value of two or more explosives. All of the points which I have just mentioned have their material effect on the value of an explosive, and much can be and is learned by study of an explosive at the laboratory, but the actual use of an explosive in practical work is necessary before a definite knowledge of the explosive can be obtained.

In this connection there is a point to which I wish to call your particular attention, and that is to the fact that the strength of an explosive does not entirely depend upon the per cent of nitro glycerin in the explosive. Suppose you were making a test of two explosives, each containing the same amount of nitro glycerin. One of these explosives may be found to be very much stronger than the other, depending entirely on the other components of the explosives. This method of grading explosives by the per cent of nitro glycerin contents is still in general use, and I feel that you will agree with me that this is very unfortunate both for the consumer and the reliable manufacturer. The consumer desires an explosive having the proper strength and quickness and quality to do the work he has to do without regard to the per cent of nitro glycerin in the explosive.

ED. NOTE.—*Mr. Gunsolus showed a large number of slides illustrating laboratory apparatus for testing explosives, and different methods of using explosives in various lines of work, which we shall not attempt to reproduce.*

Discussion

Q.—I should like to ask Mr. Gunsolus what the general practice is—do they use dry batteries to amount to anything for firing electric shots?

A.—Yes. The only trouble with the majority of dry cells, for instance, the dry cells on door bells, is that they wear out quite quickly and misfires of explosives result, although I will say in some quarries, one near Cleveland, I think, where they are using dry cells, they are having good results. They watch them carefully and replace them when necessary. As a general proposition we do not recommend them. The fact of the matter is, we would rather see a power circuit used if possible.

Q.—I should like to ask if there is any special method of draining swamp lands?

A.—Yes. We have been quite successful. We have been able to drain swamps by blasting down through impervious strata so that the water would drain through it.

Q.—About what depth did you go?

A.—Some places twenty and thirty feet deep. We, of course, used different charges of explosives; the deeper, the heavier the charge—the idea being to form a crater.

There is one point I should like to make plain, and that is concerning the strength of explosives. When explosives were first manufactured, they started with nitro glycerin, consequently if any explosive contained 40 per cent nitro glycerin, they called it 40 per cent strength; if it contained 60 per cent nitro glycerin, they called it 60 per cent strength. With gelatin, they use about 30 per cent nitro glycerin in a 40 per cent strength; that is legitimate and is all right. In addition there are other explosive ingredients which bring it up to a 40 per cent strength explosive. There are explosives which we manufacture today which are low freezing and 40 per cent strength, or they may be 60 per cent strength, but they do not contain anywhere near 40 per cent or 60 per cent nitro glycerin. One explosive contains only 10 per cent of nitro glycerin.

Then there is another point; it is not only the strength of an explosive, but the quickness, too. In other words, all the gelatin explosives of different strengths have the same quickness. With the nitro glycerin explosives, the different strengths have different degrees of quickness. The 30 per cent strength is quicker than the 20 per cent strength. The gelatins, however, are very dense and in this way make up for their lack in quickness. Gelatin will average 88 cartridges, $1\frac{1}{4}$ inches x 8 inches to 50 pounds, whereas nitro glycerin dynamite will average about 98 cartridges, $1\frac{1}{4}$ inches x 8 inches to 50 pounds. The quickness as well as the strength plays a most important part in these explosives. As we send our men over the field, we find in a great many instances we can reduce the strength of explosives, depending on the kind of material they are blasting.

Q.—What is this new explosive called *dynalite*?

A.—What do you mean?

Q.—I was talking with the representative of an explosive concern the other day and he was telling me about an explosive called *dynalite*. He said it could be handled with more safety than other explosives.

A.—I might tell you a little experience. A man working for the DuPont Company for some little time, left to work for another explosive company. I met him soon after in a hotel in West Virginia. He said, "I have an explosive now that you can hammer on an anvil and you can run a red hot poker into it." I said, "All right, I am very glad to hear it, but don't bring it around here." He did bring a cartridge around, scraped some explosive out on a piece of paper, struck a match, and jabbed the match into the powder; fortunately nothing happened. Shortly after that we heard of explosions all over the country. We investigated them, and nearly every report that was received stated that the man who was nearest the point of explosion said the first thing they heard was a sort of a slush, or boom, and then the explosion. We afterwards found it was the very explosive this man had in the hotel. That shows to me that explosives should not be handled carelessly. I don't want to say by that, and I don't want any of the gentlemen here to understand from that remark, that I was considering *dynalite*. He is a competitor of ours, and I would not say anything detrimental about a competitor.

Q.—I should like to ask in regard to large blasts in tunnels, if you can give the total cost per cubic yard of the blast. I think one of those shown tonight was a little over \$0.02 per yard; can you give us the total cost?

A.—I cannot now, but I feel sure I can give it to you if you care to have it. You can figure the cost of driving the tunnels about doubles the cost per yard.

Q.—In computing costs of explosives, did those costs include the tunnel work, that is the preparation of the holes or jams?

A.—No. It would be about double the figures I showed.

Q.—In other words, the cost of preparing for the blast is equal to the blast itself?

A.—About.

Q.—How does that compare with drilling holes?

A.—I think the well-drill is cheaper.

Q.—Can you give us the cost of blasting a stump, say 2 to 3 feet in diameter?

A.—A great deal depends, in stump blasting, on the nature of the soil; in other words, if you have a sandy soil you will need more and quicker explosives than you will in a tough clay soil, the idea being, a sandy soil gives quicker than a clay soil. As the gases of explosives are always seeking the least resistance, or expand in that direction, they will spread out more in sand than in clay. In that connection I might say that we used to recommend nothing but a 60 per cent strength nitro glycerin for stump blasting;

now we are recommending 15 per cent and 20 per cent strength explosives; it is cheaper for the farmer. The cost of explosives depends upon the strength of the explosives used. In many instances farmers cannot buy direct from the manufacturer, so they buy from some dealer, and of course they have to pay more. You can generally figure about a cent per blasting cap, and fuse one-half to three-quarters of a cent per foot. The fuse will burn about thirty seconds per foot or three feet in about a minute and a half.

Q.—Can you tell us anything about the cost of preparing the stump for the blast?

A.—If you use an ordinary auger, where much depends on muscle power, it will cost about 15 cents per stump; if you use some of the boring tools that the United States Tool Co., American Saw Mill Machinery Company and several others throughout the country are manufacturing, you can drill stumps for from 3 to 5 cents up. The initial cost for boring tools is the highest, because you have to pay \$200 to \$300 for your outfit.

Q.—I happen to know of a place in Michigan where machines are used; they use horsepower and the pine stump is pulled bodily from the ground. The cost of pulling ranges from 15 to 45 cents per stump, and according to your figures you cut it in two.

A.—In addition to that you must take this into consideration; a stump puller will pull the stump out by the roots with the dirt clinging to it. Now it is just as hard to handle that stump out of the ground as in it. If you use explosives right, you can not only blast the stump out of the ground, but break it up and knock off the dirt at the same time so that it can be easily handled.

Q.—How do you determine the holes in blasting shale?

A.—That would depend on the diameter of the drill, the depth of the holes and the character of the shale. With well drilled holes we space them 20 to 25 feet apart, and the same distance back from the face. However, if there is a pretty hard toe, we will bring them closer to the face, in other words, if the burden at the bottom of the quarry is pretty tight, we will make them less at the top. In tripod drills they space the holes 10 to 12 feet apart. If you can spring the holes and get a good sized pocket in the bottom of the holes, you can space the holes farther apart.

Q.—I should like to ask, what explosives are used for gas and oil wells and as to the power of the explosive.

A.—First, a solidified nitro glycerin, or S. N. G. 100 per cent strength; 92 per cent nitro glycerin and 8 per cent nitro-cellulose. In other words, it is a gelatin, very quick, very strong, and very water resisting. You have all seen pots of jelly; that's what it looks like. It can be packed in cartridges, and is a high freezing explosive. Of course, nitro glycerin can be used with very good effects, but it is not so safe.

Q.—What would be the strength of this S. N. G. as compared to nitro glycerin?

A.—I should say it would be about 15 per cent to 20 per cent stronger.

Q.—I should like to ask how Red Cross explosives are rated?

A.—On the strength.

Q.—What is the per cent of nitro glycerin?

A.—You are getting into chemistry and I can't answer that. The explosives which we manufacture and which do not contain as much nitro glycerin as the per cent strength indicates, are mostly nitrate of ammonia, nitrate glycerin; there are many kinds of these explosives, such as Red Cross Extra and Monobel, the latter being a coal mine explosive. These are some of the explosives which do not contain the per cent of nitro glycerin which their name indicates. A great many people feel that the manufacturer of explosives is cheating them, as explosives are not sold on the per cent of nitro glycerin, but on the per cent strength basis.

Q.—The reason I asked that question was that I used a little of the Red Cross 25 per cent and got as good results as 40 per cent of another make. I wondered whether it was rated on the strength.

A.—There is where you had a weaker and slower explosive. There is the difference. You have a deduction to make here, whether it is going to require a strong, quick explosive or a strong slower explosive; that is what we have to work against all the time.

Q.—I should like to ask, in tunneling, when you put the pockets in the tunnels, how do you deposit the explosive in the tunnel?

A.—Do you mean the bore holes in the tunnel?

Q.—No.

A.—Oh, I know now what you mean. The sump may be a foot and a half or two feet below the tunnel floor. If blasting powder is used, it is generally packed in the sump in the kegs with about 50 per cent of the bungs of the kegs opened. To detonate this we generally use from 50 pounds to 250 pounds of dynamite. If a low powder, such as Judson R. R. P. is used, and the work is very wet, this explosive is left in the cases and packed in the sumps; if the work is dry, the Judson R. R. P. is left in the small paper bags, each bag weighing $12\frac{1}{2}$ lbs., and these, in turn, packed solidly into the sump. To detonate a Judson R. R. P. charge, we generally figure on using one pound of dynamite to 25 pounds of Judson R. R. P.

Q.—Do you use any tamping at all?

A.—Yes, that is a very important thing. After the explosive is placed in the sump, you have anywhere from one to three electric fuzes in each charge of explosive. The wires from these electric fuzes must be carried out to the mouth of the tunnel. Very often in tamping, the wires are broken or the insulation is scraped off, which, of course, causes a short circuit. The wires must, therefore, be well protected while tamping and precautions taken to see that they are in no way damaged. In order

to best accomplish this, it is well to use a galvanometer to make tests of the circuit every 10 feet; in other words, fill up the tunnel with tamping material for 10 feet and test the circuit. If it shows the right resistance, then the galvanometer will so indicate; if it shows the wrong resistance, then some break or some insulation has been scraped off the wires in the 10 feet of tamping placed in the tunnel. By following this method one can eliminate a considerable amount of work, because it is only necessary to take out a maximum of 10 feet of tamping. The tunnel should be tamped very thoroughly from the charge of explosives to the mouth, so that there will be no chance of gases formed by the explosion escaping.

Q.—Is there any way then of knowing whether all the powder used in these tunnels completely explodes?

A.—There is none. However, a man who has had considerable experience in blasting would know, because they seldom load an excessive amount of explosives in the bore hole or in the tunnel to do the work required. If this amount of work is not accomplished, it shows that something is wrong, either that all the explosives had not detonated or that it was not properly loaded. I know some accidents have happened to steam shovel men due to unexploded powder, but this is more often the fault of the handling of the explosives than the fault of the explosives themselves.

Q.—Can you tell about the permanency of the benefits of explosives in subsoiling?

A.—We have been at it now for three years. We know of instances where it showed better results the second and third year than it did the first year. I think it is no question but that it is a permanent thing if done in the proper way and at the proper time. It must not be done when the ground is wet, it is absolutely money thrown away if subsoiling is done when the ground is wet.

Q.—How often do they blast this subsoil?

A.—I should say roughly, once in ten years. We have not determined that definitely, but we feel that once in ten years is enough.

Feb. 25, 1913.

MODERN EXPLOSIVES AND THEIR USE.

- Electrical Engineer** (London), Nov. 3, 1911—Electricity in Connection with Explosives, by E. K. Scott. Abstract of paper read before the Association of Mining and Electrical Engineers. Considers the using of electric power for making explosives, and the use of electricity for discharging of explosives in underground work.
- Engineering and Mining Journal**, Mar. 26, 1910—Permissible Explosives as Used in Coal Mines, by J. J. Rutledge. Direction for the intelligent use of the new explosives, and the economy resulting.
- Engineering and Mining Journal**, Feb. 3, 1912—Recent Developments in Explosives, by A. E. Anderson. Reviews briefly the development, especially the recent manufacture of powders from nitroglycerine and with or without nitrate of ammonia.
- International Library of Technology**, Vol. 88, Sec. 36—Explosives and blasting.
- Journal of The Franklin Institute**, Aug., 1910—Explosives, by F. H. Gunsolus. Brief review of advances made in the manufacture, handling, storage and use of explosives since 1886.
- Journal of the Society of Arts**, Dec. 25, 1908—Twenty Years' Progress in Explosives, by Oscar Guttman. A review of progress, giving information concerning their manufacture, composition, etc. Serial.
- Mines and Minerals**, Nov., 1910—Blasting Supplies, by F. H. Gunsolus. On the importance of proper apparatus for firing and detonating explosives.
- Mining and Scientific Press**, Nov. 20, 1909—Explosives in the U. S. During the Last Three Years, by C. E. Munroe. Read at the International Congress of Applied Chemistry. Reviews the progress of the explosives industry.
- Mining World**, Sept. 4, 1909—Principles and Compositions of Explosives, by A. L. Hodges. An explanation of the principle, and a discussion of the composition of the most used explosives.
- Scientific American**, June 24, 1911—Dynamite as a Railroad Builder, by Willard Young. Remarks on its use in the reconstruction and building of railroads.
- U. S. Bureau of Mines**, Bul. No. 10—The Use of Permissible Explosives, by J. J. Rutledge and Clarence Hall. Information intended primarily for coal mines, especially for those working where inflammable gas or coal dust may cause explosions.
- U. S. Geological Survey**, Bul. 423, 1909—A Primer on Explosives for Coal Mines, by C. E. Munroe and Clarence Hall. Aims to tell what explosives are and how they should be handled to prevent accidents.
- Weaver, E. M.**—Notes on Military Explosives, 1906.

Society Notes

MINUTES OF MEETINGS.

February 11th, 1913. Regular meeting called to order by Past President Wellman, at 8:00 p. m. Present about 145 members and guests.

The minutes of the meeting of January 14th, and the records of the meetings of January 21st and 28th were read and approved.

The Secretary read the following list of names of men elected to membership at the meeting of the Board held February 10th:

For Active Membership:

F. B. Allen,	E. S. Jackson,
R. G. Backus,	Z. B. Leonard,
W. P. Brown,	R. S. Mayer,
D. S. Cole,	A. P. Seltzer,
H. K. Ferguson,	M. B. Shea,
H. F. Gilman,	M. H. Sussman,
R. D. Grant,	H. R. Taylor.
Walter Grothe,	

For Associate Membership:

A. C. Behlen.

For Corresponding Membership:

C. M. Osborn.

Similarly announcement was made to the effect that the following men have applied for membership in the Society:

For Active Membership:

W. H. Alexander,	P. R. Jackson,
C. W. Bach,	C. J. Paterson,
C. B. Covert,	Frank B. Rae,
B. O. Crites,	W. C. Willard.
Christian Gottwald,	

For Associate Membership:

W. J. Bahr,

J. P. Newman.

For Junior Membership:

R. C. Heinmiller,

J. A. Moffet.

The Chairman then introduced Mr. C. D. Smith, of the Bureau of Mines, Pittsburgh, who presented an illustrated paper on "Gas Producers and Producer Gas", followed by an interesting discussion.

The Secretary read a communication from Mr. R. B. Chillas, Secretary of the Cleveland section of the American Institute of Electrical Engineers, inviting the members of our Society to attend the next meeting of their organization (February 17th, at the plant of the Adams-Bagnall Electric Company), which promised to be of special interest.

Adjourned.

DAVID GAEHR, Secretary.

February 18th, 1913: Informal meeting called to order by Mr. J. H. Stratton, at 7:55 p. m. Present, 44 members and guests.

The Chairman introduced Prof. H. B. Dates, head of the Electrical Engineering Department of Case School of Applied Science, who presented an illustrated paper on "The Calibration of Electrical Instruments". Many interesting and important points were brought out and many questions asked, all of which were ably answered by the speaker.

Adjourned.

DAVID GAEHR, Secretary.

February 25th, 1913: Meeting called to order by Vice President W. O. Henderer at 8:00 p. m. Present 76 members and guests.

The Chairman introduced Mr. F. H. Gunsolus, Manager, Research Division of the E. I. DuPont De Nemours Powder Company, of Wilmington, Delaware, who presented an illustrated paper on "Modern Explosives and Their Use", the paper being followed by a lively discussion brought out by questions from the audience.

Adjourned.

DAVID GAEHR, Secretary.

March 11th, 1913: Regular meeting called to order at 7:45 p. m., by President Himes. Present 160 members and guests.

Minutes of meeting of February 11th and records of meetings of February 18th and 25th were read and approved.

The Secretary read the following list of names of men elected to membership at the meeting of the Board held March 10th.

For Active Membership:

W. H. Alexander,	P. R. Jackson,
G. W. Bach,	C. J. Paterson,
C. B. Covert,	Frank B. Rae,
B. O. Crites,	W. C. Willard.
Christian Gottwald,	

For Associate Membership:

W. J. Bahr,	J. P. Newman.
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For Junior Membership:

R. C. Heinmiller,	J. A. Moffet.
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Similarly announcement was made to the effect that the following men have applied for membership in the Society:

For Active Membership:

W. W. Flagle,	W. G. Stephan,
C. P. Spangler,	E. P. Sawhill.
Marcellus Reid,	

For Transfer, Associate to Active:

R. A. Bogardus.

For Associate Membership:

J. P. Buchanan,	E. J. Knapp.
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For Junior Membership:

W. J. Rees.

On motion to elect by acclamation and by one vote seven members to constitute a Nominating Committee, in accordance with the provision of the Constitution, the following gentlemen were selected:

F. D. Davis,	S. T. Wellman,
F. C. Osborn,	C. E. Drayer,
Willard Beahan,	A. F. Blaser.
F. H. Vose,	

President Himes gave a brief account of business transacted by the Executive Board since the last regular meeting. He then introduced Mr. H. H. Smith, Chief of Research Department, Edison Storage Battery Company, of Orange, N. J., who presented a very instructive illustrated paper on "Storage Batteries", which was followed by an interesting discussion and an animated repartee between the President and ex-President Roberts, the keen wit of which was thoroughly enjoyed by all.

Adjourned.

DAVID GAEHR, Secretary.

May, 1913

March 18th, 1913: Informal meeting at the rooms called to order at 8:00 p. m., by E. S. Carman. Present, 42 members and guests.

Mr. Carman introduced H. A. Baumhart, Manager Cleveland District, The Hartford Steam Boiler Inspection & Insurance Company, who presented a paper on "The Board of Boiler Rules and Its Work". An interesting discussion followed.

Adjourned.

G. S. BLACK, Acting Secretary.

March 25th, 1913. Special meeting called to order by President Himes, at 8:00 p. m. Present, 120 members and guests.

Mr. Himes introduced C. D. Watson, of New York City, who presented an illustrated paper on "The Application of Unit Methods to Reinforced Concrete Construction". The discussion which followed was participated in by Messrs. Saurbrey, Osborn, Irwin, Mullen, Emerson and Tower. Many questions were asked which brought out interesting phases of this class of construction.

Adjourned.

G. S. BLACK, Acting Secretary.

INSPECTION TRIP.

Some fifty members and guests of the Society made an inspection trip through the plants of the Standard Tool Company and the Warner & Swasey Company on the afternoon of April 1st.

The Standard Tool Company is equipped throughout with the most modern machinery, designed in the main by its own experts, for the manufacture of twist drills, THE STANDARD TOOL CO. milling cutters, reamers, taps and special tools. In the two hours allowed to cover the five and one-half acres of floor space of this plant, it was necessary to pass much with but a cursory examination. But the laboratory and the testing rooms held our attention and interest.

Samples of all steels used in the manufacture of tools must go to the laboratory for examination under the microscope for structure, and to the testing machine for hardness both before and after annealing and after hardening and tempering. The hardening and annealing departments are equipped with appliances, continually calibrated by the laboratory force, for proper regulation of heat. The equipment includes instruments for determining the critical points of steel, a Pratt & Whitney measuring machine, which will divide 0.001 inch into 80 parts, and a set of Johansson combination gauges.

The testing room contains the only testing drill press of its kind in the world. It occupies a space $5\frac{1}{2}$ ft. x $7\frac{1}{2}$ ft., is 12 ft. high, and weighs about ten tons. The spindle is driven by a 15-h. p. motor, and the feed mechanism by a 5-h. p. motor, which gives the machine a capacity to drive a 2-inch high speed drill to destruction. The spindle can be regulated to run from 1 to 1,600 revolutions per minute with a feed of 0.0005 per revolution up to anything that is desired. Tachometers show the revolutions of the spindle and feed mechanism, and Watt meters show the horse power consumed by each.

The special feature of this machine is the pressure gauges, which show the total pounds pressure exerted on the point of the drill. Much valuable data has been obtained through tests showing the pressure and horsepower required for drills of different point clearance, thickness of web, angle of spiral and angle of point. A representative lot of all drills must undergo test in this machine before being passed.

In the room devoted to hardening and tempering, every precaution is apparently taken to insure uniformity. Not only is all daylight excluded so that colors of heated steel are viewed under uniform conditions, but all furnaces are connected to a recording pyrometer, constantly read by an expert operator who signals to the men in charge of the furnace any variation from the proper heat.

In the mind of the public, the Warner & Swasey Company is most often associated with the manufacture of astronomical instruments. Nevertheless the main product of this company is machine tools, including turret lathes, turret screw machines, automatic boring and tapping machines, and valve milling machines. Especial interest was apparent on the part of the mechanical engineers of the party in the work of grinding spindles, and grinding and boring holes through shafts. In the boring operation, the drill remains stationary while the shaft which is being bored revolves. Machines are driven by motors—either individual or group drive.

The order of manufacture is to make the lighter parts and do minor assembling on the upper floors of the plant. In the main erecting room on the first floor the work that has been done above meets the bed of the machine and is assembled into finished product.

Everyone was deeply interested in the astronomical instruments made by the Warner & Swasey Company. We stood around the most accurate dividing engine in existence, listened to one of the officers of the company explain how the engine works and how it can graduate a circle so that the greatest error possible is less than one inch in three miles. It is set on a concrete pier in the basement of the building in a specially built room. Before the engine is used, the room is heated to a constant temperature for about three days. Even the operator is not permitted in the room while a circle is being divided. Power to drive the engine is furnished by a water motor operated by a column of water of constant height.

This company designed and built the thirty-six-inch telescope at the Lick observatory and the forty-inch telescope at the Yerkes observatory. It is also the maker of the instrument by which time is daily observed at Washington.

Through a machine room on an upper floor we were conducted into the class room of the apprenticeship school, where a four-year course is given. Recitations are held daily from eight to ten in the morning and from twelve to two in the afternoon. Each boy attends twice a week under full pay. A branch of the public library is maintained and contains books adapted to reference work for the apprenticeship school, and general reading for the shop men. Club life is provided in connection with the school where the teachable youth may learn to co-operate with his fellows.

I John Paul Jones
Full Christian names and surname

Residing at Cleveland, Ohio
City or town, county and state

being desirous of admission into The Cleveland Engineering Society

as An Active Member
State class of membership

Submit the following Statement of my professional experience:

Born at Sandusky, O., Dec. 14, 1875.
To embody the place and date of birth, and concise narrative, with dates, of

TRAINING: Graduated from Public Schools, June,
The Candidate's professional education and career, specifying the positions he has

1890. Graduated from Sandusky High School
held, the nature and extent of the work in or upon which he has been engaged.

June, 1894. Graduated from Ohio State
giving an idea of their magnitude and importance. All proper names names of

University in M.E. course, June, 1898, re-
degrees, etc., must be written without abbreviation.

ceiving degree of M.E.

PRACTICAL TRAINING & EXPERIENCE:

- (1) Cummer, 1894: Fireman on Steamer J.E.A. Moore.
- (2) Summer, 1895: Oiler on private Steam Yacht "Dreaver", owned by G.P. Burrows.
- (3) Summer, 1896: Handy man in machine shops of Green White, Boston, Mass.
- (4) Summer, 1897: Tracer in Engineering Department of City of Sandusky (Water Works).
- (5) Since Graduation from O.E.C.: Served as Special Apprentice, Glowe & Dales Mfg. Co., Pittsburgh, Pa., July 1, 1898, to June 30, 1901.
- (6) In charge of A.C. Motor Testing Department: July 1, 1901, to Oct. 10, 1901, with same company.
- (7) Erecting Engineer (large motors and generators) Oct. 11, 1901 to March 20, 1902.

- (8) Assistant Superintendent, the Herron Heating Company, Lakewood, O., April 1, 1902, to Aug. 10th, 1905.
- (9) Superintendent, Roberts & Abbott Railway Company, Power House at Homestead, Pa., August 15, 1905 to June 15, 1910.
- (10) Electrical Engineer, Railway Department, Joseph R. Poe Engineering Co., Cleveland, July 1, 1910 to July 1, 1912.
- (11) Consulting Electrical & Mechanical Engineer from July, 1912 to date.

I will conform to all the requirements of membership, if elected as

Active
State class of membership
Signed John P Jones
Residence 6000 Euclid Avenue

Place of Business 427 Schofield building.

Date May 10, 1913.
Applicant will fill in this date

On the grounds stated, and because we believe him from personal knowledge to be in all respects a proper person to be admitted into The Cleveland Engineering Society, we hereby recommend the above applicant for election as

Active
Class of membership
Proposed by W. D. Alexander
E. H. Whitlock

CHARACTER & IMPORTANCE OF WORK REFERRED TO:

- Nos. 1,2,3,4, include ordinary work usually attached to the positions mentioned.
- No.5 comprised, besides practical work, a course of study relating to the work done in the Testing Departments (motors, generators, turbines), in the drafting room and in the shop superintendent's office.
- No.6 embraced complete testing of A.C. machines and plotting curves of the results obtained
- No.7 Comprised erecting and testing a 250 K.W. generator at the plant of the Baldwin Rubber Co., Philadelphia, (one month), trouble work at the Watson Railway & Light Company's plant, Scranton, Pa. (10 days), erecting three 1,500 K.W. generators for the Panama Railway Co. (six months), installing equipment in six sub-stations for the Henderer Traction Company, Cleveland, (six months), The rest of the time was spent in the erecting department at the works.
- No.8 embraced the duties ordinarily included in the management of a heating plant.
- No.9 comprised the duties of a superintendent in complete charge of a large power house.
- No.10 Refers to duties in charge of design and installation of a 2,500 K.W. power plant for the J.W.Frazier Mining Company at Denver, Colo.; also 10,000 K.W. power plant for Drayer & Irwin Railway Syndicate, Panama, including complete station and sub-station equipment of the latter, costing \$1,500,000.
- No.11 private practice specializing along lines of electric railway and general power plant work.

NOTE:

An application blank should be filled out completely; if not a technical graduate, state how long in attendance at such an institution, or under private tutors, or what work was covered in night or correspondence schools.

Be particular to state length of time in various positions, and the nature and importance of the work; also, if you are a member of any other engineering organizations give names and state class of membership.

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P Tech C

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